Chapter 2
Standard Urban Storm Water Mitigation Plan (SUSMP)
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2.1 STANDARD URBAN STORM WATER MITIGATION PLAN (SUSMP) INTRODUCTION

2.1.1 Standard Urban Storm Water Mitigation Plan Organization

Chapter 2 of the Storm Water Standards Manual serves to guide to project proponents on compliance with the permanent storm water quality requirements for development projects in the City of Carlsbad. This Chapter guides the project applicant through the selection, design, and incorporation of storm water Best Management Practices (BMPs) into the project's design plan.

Chapter 2.1, "Introduction," describes storm water pollution background information and legal or regulatory requirements associated with storm water pollution control.

Chapter 2.2, "Project Review & Permitting Process," outlines the review and approval process for development projects. Project proponents should use Chapter 2.2 to help navigate through the project review and approval process to ensure storm water requirements are incorporated into their projects. .

Chapter 2.3, "Permanent Storm Water BMP Selection Procedure," lists the anticipated project pollutants and recommended permanent storm water BMP requirements, which are organized in a progression intended to dovetail with a typical project planning and design process and maximize storm water protection while minimizing project costs.

Chapter 2.4, "Implementation & Maintenance of Requirements," describes how implementation and maintenance of permanent BMPs must be assured prior to discretionary approval.

The Appendices to the Standard Urban Storm Water Mitigation Plan contain information either necessary or designed to provide guidance in completing the storm water requirements in this plan.

2.1.2 Background

Urban runoff discharged from municipal storm water conveyance systems (drainage channels and storm drains) has been identified by local, regional, and national research programs as one of the principal causes of water pollution in most urban areas. The City of Carlsbad's storm water conveyance system, which collects runoff from our streets, rooftops, driveways, parking lots, and other impervious areas, flows to our lagoons and beaches without being treated (our storm water conveyance system is separate from our sanitary sewer system). Urban runoff potentially contains a host of pollutants like trash and debris, bacteria and viruses, oil and grease, sediments, nutrients, metals, and toxic chemicals. These contaminants can adversely affect receiving and coastal waters, associated wildlife, and public health. Urban runoff pollution is not only a problem during rainy seasons, but also year-round due to many types of urban water use that discharge runoff (dry weather flow) to the storm water conveyance system.

Land development and construction activities significantly alter drainage patterns and contribute pollutants to urban runoff primarily through erosion and removal or change of existing natural vegetation during construction, and the creation of new impervious surfaces, such as parking lots, which often permanently contribute pollutants throughout the "use" of the project site. When homes, work places, recreational areas, roads, parking lots, and structures are built, new impervious areas are built- creating the potential for an impact to water quality. The natural landscape's ability to infiltrate and cleanse storm water and urban runoff is "capped" by the impervious surfaces. As impervious surfaces increase, water that normally would have percolated into the soil now flows over the land surface directly to downstream wetlands, creeks, and eventually the Pacific Ocean. Accordingly, increases in impervious cover can increase the frequency and intensity of storm water flows. Second, new impervious surfaces often become a source of pollutants associated with development, such as automotive fluids, cleaning solvents, toxic or hazardous chemicals, detergents, sediment, metals, pesticides, oil and grease, and food wastes. These pollutants, which are often temporarily captured on impervious surfaces, are transported to the storm water conveyance system by storm water and urban runoff. The pollutants flow untreated through the storm water conveyance system and ultimately into our creeks, rivers, beaches, and ocean. With the growing concerns of urban runoff and storm water pollution, local, state, and federal agencies devised regulations requiring development planning and construction controls to treat storm water-related pollution from new development projects before it reaches any receiving waters.

Order R9-2007-0001 (Municipal Permit) was issued on January 24, 2007 to the City of Carlsbad, the County of San Diego, the San Diego Unified Port District, the San Diego Regional Airport Authority, and 17 other cities within the region administered by the San Diego Regional Water Quality Control Board (Regional Board). The Municipal Permit addresses the implementation of storm water regulations for private and public development projects. Specifically, development projects are required to include storm water best management practices (BMPs) both during construction, and in the projects permanent design, to reduce pollutants discharged from the project site to the maximum extent practicable.

The primary objectives of the Storm Water Standards are to: (1) effectively prohibit non-storm water discharges; and (2) reduce the discharge of pollutants from storm water conveyance systems to the Maximum Extent Practicable (MEP statutory standard) throughout the life of a developed site. To address pollutants that may be generated from new development once the site is in use, the Municipal Permit further requires that the City implement a series of permanent BMPs described in a document called the Model Standard Urban Storm Water Mitigation Plan, or Model SUSMP (pronounced "sue-sump"), which was approved by the Regional Board on June 12, 2002.

2.1.3 Legal Framework

The requirement to implement storm water BMP's into development projects originates from Section 402 (p) of the Federal Clean Water Act. The Federal Clean Water Act amendments of 1987 established a framework for regulating storm water discharges from municipal, industrial, and construction activities under the National Pollution Discharge Elimination System (NPDES) program. Under the Federal Clean Water Act, municipalities throughout the nation are issued a Municipal NPDES Permits. The primary goal of a Municipal NPDES Permit is to stop polluted discharges from entering the storm water conveyance system and local receiving and coastal waters.

In California, the State Water Resources Control Board (SWRCB), through the nine Regional Boards, administers the NPDES storm water municipal permitting program. Based on the Municipal Permit issued by the San Diego Regional Board, the City is required to develop and implement permanent storm water BMPs to eliminate and/or reduce pollution from new development projects to the MEP.

2.2 PROJECT REVIEW AND PERMITTING PROCESS

2.2.1 Introduction to Review and Permitting Process

The City of Carlsbad's Storm Water Management and Discharge Control Ordinance (Carlsbad Municipal Code Chapter 15.12), requires that all new development and redevelopment activities comply with the storm water pollution prevention requirements. These storm water pollution prevention requirements, which are described in detail in Chapter 2.3, "Permanent Storm Water Best Management Practices Selection Procedure," are site specific and vary based on the project's potential impact on receiving water quality.

The steps below describe the elements of the plan review and permitting processes for storm water best management practice (BMP) requirements. The flow chart in Figure 1, "Review Process for Discretionary Actions" demonstrates how storm water requirements are incorporated into projects requiring subdivision approvals, development permits or other discretionary actions.

For projects that do not require discretionary action, City staff will require that all appropriate SUSMP requirements are incorporated into the project design and shown on the plans prior to issuance of any ministerial permit.

The process for issuance of ministerial projects includes (1) receipt of an application, (2) determination of application completeness, (3) staff review of application, including appropriate storm water requirements and (4) issuance of a ministerial permit. The applicants are required to complete a "Standard Urban Storm Water Mitigation Plan Questionnaire" (Appendix A) as a part of their project submittal to determine the level of storm water requirements, including SUSMP requirements that will be a part of the project design and shown on the plans.

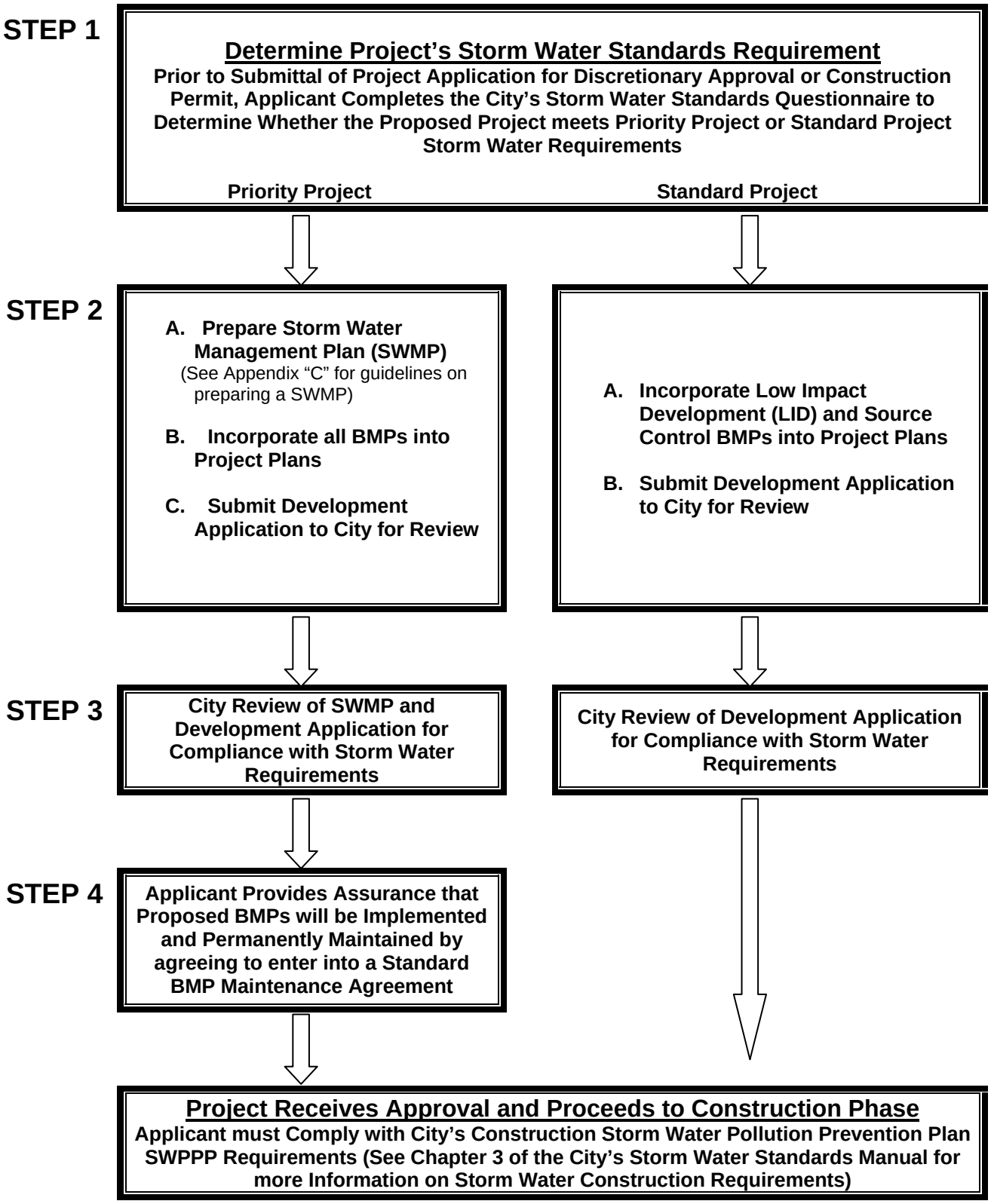
2.2.2 Step 1 : Determine Applicable Permanent Storm Water BMP Requirements

Prior to submittal, applicants must complete the "Storm Water Standards Questionnaire" in Appendix A. This questionnaire must be completed, signed by the responsible party for the project, and submitted with your permit application. The questionnaire will determine if the project requires Standard BMPs, Priority BMPs or is exempt from SUSMP requirements as described below. Projects meeting priority requirements must include a Storm Water Management Plan (SWMP) with their project. Appendix "C" provides guidelines for the preparation of a SWMP.

Note: The questionnaire form referenced above must be completed for all permit applications, even if previous approvals exist. Projects requesting additional construction permits or discretionary approvals (including permit extensions and amendments), even though previous permits and/or approvals have been obtained, will be required to comply with the storm water requirements in this document

Figure 1

Review Process for Discretionary Actions



2.2.3 Permanent Storm Water BMP Requirements

2.2.3.1 Standard Project Requirements.

Projects subject to only the standard permanent storm water requirements must incorporate the LID site design and source control requirements identified in Chapters 2.3.3.1 and 2.3.3.2, into the project (see Table 1). Refer to Chapter 2.2.4 "Step 2 - Prepare & Submit Appropriate Plans," for guidance in the BMP design process.

2.2.3.2 Priority Project Requirements

All new development and significant redevelopment projects that fall into one of the following "priority project" categories are subject to these SUSMP requirements, subject to the lawful prior approval provisions of the Municipal Permit. In the instance where a project feature, such as a parking lot, falls into a priority project category, the entire project footprint is subject to these SUSMP requirements. These categories are:

Residential development of 10 units or more
Commercial development greater than 1 acre
Heavy industry development greater than 1 acre
Automotive repair shops
Restaurants
Hillside development greater than 5,000 square feet
Projects located within or directly adjacent to or directly discharging to receiving waters within Environmentally Sensitive Areas that create 2,500 square feet or more of impervious surface or increase the area of imperviousness to 10% or more of its naturally occurring condition
Projects greater than 2,500 square feet of impervious surface that discharge to receiving waters within or adjacent to Environmentally Sensitive Areas
Parking Lots 5,000 square feet or more impervious surface or with > 15 parking spaces and potentially exposed to urban runoff
Streets, roads, driveways, highways, and freeways which would create a new paved surface that is 5,000 square feet or greater of impervious surface
Retail gasoline outlets 5,000 square feet or more or with a projected Average Daily Traffic (ADT) of 100 or more vehicles per day.
Project is located within 200 feet of the Pacific Ocean and (1) creates more than 2,500 square feet of impermeable surface or (2) increases the impermeable surface on the property by more than 10%.

For expanded definition of the categories described above, refer to Section D.1.d(2) of the Municipal Permit.

Limited Exclusion: Trenching and resurfacing work associated with utility projects are not considered priority projects; resurfacing and reconfiguring surface parking lots and existing roadways; new sidewalk construction, pedestrian ramps, or bike lanes on existing roads; and routine replacement of damaged pavement, such as pothole repair. Parking lots, buildings and other structures associated with utility projects are subject to SUSMP requirements if one or more of the criteria for the above categories are met.

Projects subject to priority project permanent storm water requirements must incorporate all applicable requirements in Chapter 2.3.3, "Establish Permanent Storm Water Best Management Practices," (requirements BMP-1 through BMP-33) into the project design. This includes the LID site design and source control BMPs, BMPs applicable to individual priority project categories, and treatment control BMP requirements. If a priority project meets more than one priority project category definition, as shown in Table 1, the project is subject to all BMPs applicable to individual priority project categories that apply. For example, if a project is proposing to build 50 attached residential units and a 6,000 square foot restaurant with a 70-space surface parking lot, the project would be subject to the individual priority project category BMP requirements for "Attached Residential Development," "Restaurants," and "Parking Lots," as shown in Table 1, below. Refer to Chapter 2.2.4 "Step 2 - Prepare & Submit Appropriate Plans," for guidance in the permanent BMP design process.

Table 1

Standard Development Project & Priority Project Storm Water BMP Requirements Matrix

	LID Site Design BMPs[1]	Source Control BMPs[2]	BMPs Applicable to Individual Priority Project Categories[3]										Treatment Control BMPs[4]
			a. Private Roads	b. Residential Driveways & Guest Parking	c. Dock Areas	d. Maintenance Bays	e. Vehicle Wash Areas	f. Equipment Wash Areas	g. Outdoor Processing Areas	h. Surface Parking Areas	i. Fueling Areas	j. Hillside Landscaping	
Standard Projects	R	R	R	R	R	R	R	R	R	R	R	R	O
Priority Projects:													
Detached Residential Development	R	R	R	R								R	S
Attached Residential Development	R	R	R										S
Commercial Development greater than 100,000 ft^2	R	R			R	R	R		R				S
Heavy industry /industrial	R	R	R		R	R		R	R	R			S
Automotive Repair Shop	R	R			R	R	R	R			R		S
Restaurants	R	R			R			R					S
Steep Hillside Development greater than 5,000 ft^2	R	R	R									R	S
Parking Lots	R	R								R[5]			S
Retail Gasoline Outlets	R	R				R	R	R		R	R		S
Streets, Highways & Freeways	R	R											S

R = Required; select one or more applicable and appropriate BMPs from the applicable steps in Section III.2.A-D, or equivalent as identified in Appendix B.

O = Optional/ or may be required by City staff. As appropriate, applicants are encouraged to incorporate treatment control BMPs and BMPs applicable to individual priority project categories into the project design. City staff may require one or more of these BMPs, where appropriate.

S = Select one or more applicable and appropriate treatment control BMPs from Appendix B.

(1) Refer to Chapter 2.3.3.1. LID = Low Impact Development.

(2) Refer to Chapter 2.3.3.2.

(3) Priority project categories must apply specific storm water BMP requirements, where applicable. Priority projects are subject to the requirements of all priority project categories that apply. Refer to Chapter 2.3.3.3

(4) Refer to Chapter 2.3.3.4

(5) Applies if the paved area totals >5,000 square feet or with >15 parking spaces and is potentially exposed to urban runoff.

2.2.4 Step 2 : Prepare and Submit Appropriate Plans.

After determining the general categories of storm water requirements that apply to the project in Step 1 (e.g., priority project permanent BMPs and/or standard permanent BMPs), refer to the instructions in this step (see below) to determine what analysis and/or specific BMP requirements in Chapter 2.3 of the SUSMP must be provided and/or incorporated into the project.

NOTE: Projects are only required to provide applicable BMPs. For example, an attached residential development project subject to the priority project requirements would not have to meet the "private road" requirements in this plan if no private roads were proposed. In addition, the City Engineer may approve proposed alternatives to any of the BMP requirements in this plan if they are determined to be applicable and equally effective. In all cases, priority projects shall meet the numeric sizing treatment standards in Table 3.

2.2.5 Permanent Storm Water BMPs

2.2.5.1 Standard Project Requirements

Projects subject to only standard permanent BMP requirements need only to complete the "Identify Pollutants from the Project Area" procedure (Chapter 2.3.2.1), and then incorporate the requirements in Chapter 2.3.3.1, "LID Site Design BMPs" and Chapter 2.3.3.2, "Source Control BMPs". Applicants must incorporate all necessary permanent BMPs into the project plans prior to submittal, regardless of project type. Analysis of the project's anticipated pollutants of concern must also be included with the project submittal.

2.2.5.2 Priority Project Requirements

Projects subject to the priority project permanent BMP requirements must complete all of the analyses required in Chapter 2.3.2, "Identify Pollutants and Conditions of Concern," and incorporate all of the applicable BMP requirements in Chapter 2.3.3, "Establish Permanent Storm Water BMP Requirements". Applicants must incorporate all necessary permanent BMPs into the project plans prior to submittal, regardless of project type. In addition, projects subject to priority project requirements must prepare and submit a Storm Water Management Plan (SWMP) in accordance with required sections as listed in Appendix C. Analysis of the project's anticipated pollutants of concern, anticipated pollutants of concern in downstream receiving waters, and conditions of concern, must also be included in the Storm Water Management Plan as part of the project submittal. After preparing plans and supporting documents according to the requirements in this plan, submit plans to the City for review (See Step 3)

2.2.6 Step 3 – Determine Adequacy of Proposed Plans.

Under the authority of the City Engineer, staff will review submitted plans for compliance with the applicable storm water requirements contained in this plan. The City Engineer may approve proposed alternatives to the BMP requirements in this plan if they are determined to be applicable and equally effective. Additional analysis or information may be required to enable staff to determine the adequacy of proposed BMPs, and will be requested through a project issues report following the conclusion of a staff review cycle. After all storm water requirements have been approved by the City Engineer, proceed to Step 4 to assure implementation and maintenance of the approved BMPs through permit conditions, plan notes, and maintenance agreements.

2.2.7 Step 4 -- Assure Implementation and Maintenance of Requirements.

Applicants must provide assurances that permanent storm water BMPs will be constructed and permanently maintained throughout the use of a developed site. The summary below describes how permanent BMP requirements must be assured during both discretionary approval processes. After the City Engineer has approved all permanent BMPs, refer to Chapter 4, "Implementation & Maintenance Requirements" to determine how permanent BMP implementation and maintenance will be assured.

For any discretionary action, permanent storm water requirements shall be incorporated into the project design and be shown on the plans. In addition, the project will be conditioned to execute a maintenance agreement for ongoing permanent BMP maintenance, satisfactory to the City Engineer, prior to the issuance of any construction permits. This requirement shall be noted on the plans for the discretionary action.

2.3 PERMANENT BEST MANAGEMENT PRACTICES SELECTION PROCEDURE

2.3.1 INTRODUCTION

The following process should be followed to determine the permanent BMPs for the applicant's project.

2.3.2 IDENTIFY POLLUTANTS AND CONDITIONS OF CONCERN

2.3.2.1 Identify Pollutants from the Project Area

Using Table 2 below, identify the project's anticipated pollutants. Pollutants associated with any hazardous material sites that have been remediated or are not threatened by the proposed project are not considered a pollutant of concern. Projects meeting the definition of more than one project category shall identify all general pollutant categories that apply. Descriptions of the general pollutant categories listed in Table 2 are defined in Appendix F under the definition of "pollutants of concern."

Table 2

Anticipated and Potential Pollutants Generated by Land Use Type

	General Pollutant Categories								
Project Categories	Sediments	Nutrients	Heavy Metals	Organic Compounds	Trash & Debris	Oxygen Demanding Substances	Oil & Grease	Bacteria & Viruses	Pesticides
Detached Residential Development	X	X			X	X	X	X	X
Attached Residential Development	X	X			X	P(1)	P(2)	P(1)	X
Commercial Development >100,000 ft^2	P(1)	P(1)		P(2)	X	P(5)	X	P(3)	P(5)
Heavy industry /industrial development	X		X	X	X	X	X		
Automotive Repair Shops			X	X(4)(5)	X		X		
Restaurants					X	X	X	X	
Steep Hillside Development >5,000 ft^2	X	X			X	X	X		X
Parking Lots	P(1)	P(1)	X		X	P(1)	X		P(1)
Retail Gasoline Outlets			X	X	X	X	X		
Streets, Highways & Freeways	X	P(1)	X	X(4)	X	P(5)	X		

X = anticipated
P = potential
(1) A potential pollutant if landscaping exists on-site.
(2) A potential pollutant if the project includes uncovered parking areas.
(3) A potential pollutant if land use involves food or animal waste products.
(4) Including petroleum hydrocarbons.
(5) Including solvents.

2.3.2.2 Identify Pollutants of Concern in Receiving Waters

For priority projects, the following analysis shall be conducted and reported in the project's Storm Water Management Plan:

1. For each of the proposed project discharge points, identify the receiving water(s), including hydrologic unit basin number(s), as identified in the most recent version of the *Water Quality Control Plan for the San Diego Basin*[1], prepared by the San Diego Regional Water Quality Control Board.
2. Identify any receiving waters, into which the developed area would discharge to, listed on the most recent list of Clean Water Act Section 303(d) impaired water bodies[2]. List any and all pollutants for which the receiving waters are impaired.
3. Compare the list of pollutants for which the receiving waters are impaired with the pollutants anticipated to be generated by the project (as discussed in Chapter 2.3.2.1). Any pollutants identified in the process described in Chapter 2.3.2.1 which are also causing impairment of receiving waters shall be considered pollutants of concern.

2.3.2.3 Identify Conditions of Concern

For priority projects where downstream erosion is a potential, the following analysis shall be conducted and reported in the project's Storm Water Management Plan:

1. Evaluate the project's conditions of concern in a drainage study report prepared by a registered civil engineer in the State of California, with experience in fluvial geomorphology and water resources management. The report shall consider the project area's location (from the larger watershed perspective), topography, soil and vegetation conditions, percent impervious area, natural and infrastructure drainage features, wet season groundwater depth, and any other relevant hydrologic and environmental factors to be protected specific to the project area's watershed.
2. As part of the drainage study, a qualified, licensed professional shall provide a report on proposed infiltration techniques (trenches, basins, dry wells, permeable pavements with underground reservoir for infiltration) regarding any potential adverse geotechnical concerns. Geotechnical conditions such as: slope stability, expansive soils, compressible soils, seepage, groundwater depth, and loss of foundation or pavement subgrade strength should be addressed, and mitigation measures provided.
3. As part of the drainage study, the civil engineer shall conduct a field reconnaissance to observe and report on downstream conditions, including undercutting erosion, slope stability, vegetative stress (due to flooding, erosion, water quality degradation, or loss of water supplies) and the area's susceptibility to erosion or habitat alteration as a result of an altered flow regime.
4. The Drainage study shall compute rainfall runoff characteristics from the project area including at a minimum, peak runoff, time of concentration, and detention volume (if appropriate). These characteristics shall be developed for the two-year and 10-year frequency, six-hour or 24-hour, type B storm for the Carlsbad area in San Diego County (as described in the San Diego County Hydrology Plan, September 2002). The 6-hour Type B storm yields larger peak discharges for certain smaller drainage areas (usually less than 10 square miles, depending upon area, time to peak, CN, frequency, etc.). The 24-hour Type B storm yields larger peak discharges for larger drainage areas (usually greater than 10 square miles, depending upon area, time to peak, CN, frequency, etc.). The largest peak flow should be included in the report. The report shall also report the project's conditions of concern based on the hydrologic and downstream conditions discussed above. Where downstream conditions of concern have been identified, the drainage study shall establish that pre-project hydrologic conditions that minimize impacts on those downstream conditions of concern would be either improved or maintained by the proposed project, satisfactory to the City Engineer, by incorporating the permanent BMP requirements identified in Chapter 2.3.3, below.

For Priority Development Projects that disturb 50 acres or more:

1. Priority Development Projects' post-project runoff flow rates and durations shall not exceed pre-project runoff flow rates and durations (Interim Hydromodification Criteria), where the increased

1. Go to: http://www.swrcb.ca.gov/~rwqcb9/programs/basinplan.html
2. Under Section 303(d) of the 1972 Clean Water Act, states, territories and authorized tribes are required to develop a list of water quality limited segments. These waters on the list do not meet water quality standards, even after point sources of pollution have installed the minimum required levels of pollution control technology. Go to: http://www.swrcb.ca.gov/tmdl/303d_lists.html. San Diego is in Region 9 (a link is provided).

discharge flow rates and durations will result in increased potential for erosion or other significant adverse impacts to beneficial uses, attributable to changes in flow rates and durations.

2. Priority Development Projects disturbing 50 acres or more shall implement hydrologic controls to manage post-project runoff flow rates and durations as required by the Interim Hydromodification Criteria (See Appendix G for City's Interim Hydromodification Criteria).

2.3.3 ESTABLISH PERMANENT STORM WATER BEST MANAGEMENT PRACTICES

After identifying the project's pollutants of concern, and conditions of concern (for priority projects), in Chapter 2.3.2, projects subject to standard or priority project requirements shall implement all applicable LID site design and source control BMPs listed below. Projects subject to priority project requirements must also implement the BMPs applicable to individual priority project categories and structural treatment control BMPs. Applicants may employ alternative comparable and equally effective LID site design and source control BMPs (including requirements applicable to individual priority project categories), satisfactory to the City Engineer.

Projects are encouraged to address these objectives through the creation of a hydrologically functional project design that attempts to mimic the natural hydrologic regime. Mimicking a site's natural hydrologic regime can be pursued by:

- Reducing imperviousness (such as, new surface parking lots), conserving natural resources and areas, maintaining and using natural drainage courses in the storm water conveyance system, and minimizing clearing and grading.
- Providing runoff storage measures dispersed throughout a site's landscape with the use of bioretention facilities and detention, retention, and infiltration practices.
- Implementing on-lot hydrologically functional landscape design and management practices.

These design principles offer an innovative approach to urban storm water management, one that does not rely on the conventional end-of-pipe or in-the-pipe structural methods but instead strategically integrates storm water controls throughout the urban landscape. Useful resources for applying these principles, referenced in the appendix, include *Start at the Source* (1999), and *Low-Impact Development Design Strategies* (1999) (see Appendix D). Effective source controls offer another strategy to reduce a project's need for treatment. Applicants are encouraged to design projects so that runoff is treated by LID site design BMPs, such as rooftop runoff treated in landscaping, so that it may be applied towards the numeric sizing treatment standards, satisfactory to the City Engineer. Therefore, projects shall incorporate, where applicable, storm water BMPs into the project design, in the following progression:

- LID Site Design BMPs
- Source Control BMPs
- BMPs for Individual Priority Project Categories (these are LID site design and source control BMPs)
- Treatment Control BMPs

The series of best management practices listed above are organized sequentially to allow the applicant and design professional to incorporate the LID site design, source control BMPs, and where necessary, requirements applicable to individual priority project category requirements and treatment control BMPs in this progression.

2.3.3.1 LID Site Design BMPs

Projects shall be designed so as to minimize directly connected impervious surfaces and to promote infiltration using LID techniques. Projects shall, to the maximum extent practicable, minimize the introduction of pollutants and conditions of concern that may result in significant impacts, generated from site runoff to the storm water conveyance system. Projects shall also control post-development peak storm water runoff discharge rates and velocities to maintain or reduce pre-development downstream erosion and to protect stream habitat. Projects can address these objectives through the creation of a hydrologically functional project design that attempts to mimic the natural hydrologic regime.

The following is a suite of LID Site Design BMPs to be implemented as appropriate in order to achieve SUSMP requirements.

Maintain Pre-Development Rainfall Runoff Characteristics

Control post-development peak storm water runoff discharge rates and velocities to maintain or reduce pre-development downstream erosion by applying the following concepts:

BMP-1 Minimize and disconnect impervious surfaces. (1) Increase building density (number of stories above or below ground); (2) construct walkways, trails, patios, overflow parking lots and alleys and other low-traffic areas with permeable surfaces, such as pervious concrete, porous asphalt, unit pavers, and granular materials; (3) construct streets, sidewalks and parking lot aisles to the minimum widths necessary, provided that public safety and a walkable environment for pedestrians are not compromised; and (4) minimize the use of impervious surfaces, such as decorative concrete, in the landscape design.

BMP-2 Conserve natural areas, soils and vegetation and provide buffer zones between natural water bodies and the project footprint. (1) Concentrate or cluster development on the least environmentally sensitive portions of a site while leaving the remaining land in a natural, undisturbed condition; (2) Use natural drainage systems to the maximum extent practicable (natural drainages and vegetated swales are preferred over using lined channels or underground storm drains, and; (3) minimize soil compaction.

BMP-3 Minimize Directly Connected Impervious Areas. (1) Where landscaping is proposed, drain rooftops into adjacent landscaping prior to discharging to the storm water conveyance system; and (2) where landscaping is proposed, drain impervious parking lots, sidewalks, walkways, trails, and patios into adjacent landscaping.

BMP-4 Maximize canopy interception and water conservation. (1) Preserve existing native trees and shrubs; and (2) plant additional native or drought tolerant trees and large shrubs in place of non-drought tolerant exotics.

Protect Slopes and Channels

BMP-5 Convey runoff safely from the tops of slopes.

BMP-6 Vegetate slopes with native or drought tolerant vegetation.

BMP-7 Stabilize permanent channel crossings.

BMP-8 Install energy dissipaters, such as riprap, at the outlets of new storm drains, culverts, conduits, or channels that enter unlined channels in accordance with applicable specifications to minimize erosion. Energy dissipaters shall be installed in such a way as to minimize impacts to receiving waters.

BMP-9 Minimize disturbances to natural drainages

2.3.3.2 Source Control BMPs

Design Outdoor Material Storage Areas to Reduce Pollution Introduction

BMP-10 Hazardous materials with the potential to contaminate urban runoff shall be: (1) placed in an enclosure such as, but not limited to, a cabinet, shed, or similar structure that prevents contact with rain, runoff or spillage to the storm water conveyance system; and (2) protected by secondary containment structures such as berms, dikes, or curbs. The storage area shall be paved and sufficiently impervious to contain leaks and spills, and have a roof or awning to minimize direct precipitation within the secondary containment area.

Design Trash Storage Areas to Reduce Pollution Introduction

BMP-11 Trash storage areas shall be: (1) paved with an impervious surface, designed not to allow run-on from adjoining areas, and screened or walled to prevent off-site transport of trash; and, (2) contain attached lids on all trash containers that exclude rain; or (3) contain a roof or awning to minimize direct precipitation.

Employ Integrated Pest Management Principles

Integrated pest management (IPM) is an ecosystem-based pollution prevention strategy that focuses on long-term prevention of pests or their damage through a combination of techniques such as biological control, habitat manipulation, modification of cultural practices, and use of resistant plant varieties. Pesticides are used only after monitoring indicates they are needed according to established guidelines. Pest control materials are selected and applied in a manner that minimizes risks to human health, beneficial and non-target organisms, and the environment. More information may be obtained at the UC Davis website (http://www.ipm.ucdavis.edu/WATER/U/index.html).

BMP-12 Eliminate and/or reduce the need for pesticide use in the project design by: (1) Plant pest-resistant or well-adapted plant varieties such as native plants; and (2) Discourage pests by modifying the site and landscaping design. Pollution prevention is the primary "first line of defense" because pollutants that are never used do not have to be controlled or treated (methods which are inherently less efficient).

BMP-13 Distribute IPM educational materials to future site residents/tenants. Minimally, educational materials must address the following topics: (1) Keeping pests out of buildings and landscaping using barriers, screens, and caulking; (2) Physical pest elimination techniques, such as, weeding, squashing, trapping, washing, or pruning out pests; (3) Relying on natural enemies to eat pests; (4) Proper use of pesticides as a last line of defense. More information may be obtained at the UC Davis website (http://www.ipm.ucdavis.edu/WATER/U/index.html).

Use Efficient Irrigation Systems & Landscape Design

In compliance with the Water Conservation in Landscaping Act, the following methods to reduce excessive irrigation runoff shall be implemented:

BMP-14 Employ rain shutoff devices to prevent irrigation during and after precipitation.

BMP-15 Design irrigation systems to each landscape area's specific water requirements.

BMP-16 Use flow reducers or shutoff valves triggered by a pressure drop to control water loss in the event of broken sprinkler heads or lines.

Provide Storm Water conveyance System Stenciling and Signage

BMP-17 Provide concrete stamping, or equivalent, of all storm water conveyance system inlets and catch basins within the project area with prohibitive language (e.g., "No Dumping – I Live in <<name receiving water>>"), satisfactory to the City Engineer. Stamping may also be required in Spanish.

BMP-18 Post signs and prohibitive language and/or graphical icons, which prohibit illegal dumping at public access points along channels and creeks within the project area, trailheads, parks and building entrances.

2.3.3.3 BMPs Applicable to Individual Priority Project Categories

Where identified in Table 1, the following requirements shall be incorporated into applicable priority projects. Projects shall adhere to each of the individual priority project category requirements that apply to the project (e.g., a restaurant with more than 15 parking spaces would be required to incorporate the requirements for 'c. Dock Areas', 'f. Equipment Wash Areas', and 'h. Surface Parking Areas' into the project design).

Private Roads

BMP-19 The design of private roadway drainage shall use at least one of the following (for further guidance, see Start at the Source [1999]): (1) rural swale system- street sheet flows to vegetated swale or gravel shoulder, curbs at street corners, culverts under driveways and street crossings; (2) urban curb/swale system- street slopes to curb, periodic swale inlets drain to vegetated swale/biofilter; or (3) dual drainage system- first flush captured in street catch basins and discharged to adjacent vegetated swale or gravel shoulder.

Residential Driveways & Guest Parking

BMP-20 Driveways shall have one of the following: (1) shared access; (2) flared entrance (single lane at street); (3) wheelstrips (paving only under tires); (4) porous paving; or (5) designed to drain into landscaping prior to discharging to the storm water conveyance system.

BMP-21 Uncovered temporary or guest parking on private residential lots shall be: (1) paved with a permeable surface; or (2) designed to drain into landscaping prior to discharging to the storm water conveyance system.

Dock Areas

BMP-22 Loading/unloading dock areas shall include the following: (1) cover loading dock areas, or design drainage to preclude urban run-on and runoff; and (2) An acceptable method of containment and pollutant removal, such as a shut-off valve and containment area. Direct connections to storm drains from depressed loading docks (truck wells) are prohibited.

Maintenance Bays

BMP-23 Maintenance bays shall include at least one of the following: (1) repair/ maintenance bays shall

be indoors; or, (2) designed to preclude urban run-on and runoff.

BMP-24 Maintenance bays shall include a repair/maintenance bay drainage system to capture all wash water, leaks and spills. Connect drains to a sump for collection and disposal. Direct connection of the repair/maintenance bays to the storm water conveyance system is prohibited.

Vehicle & Equipment Wash Areas

BMP-25 Areas for washing/steam cleaning of vehicles and areas for outdoor equipment/accessory washing and steam cleaning shall be: (1) self-contained to preclude run-on and run-off, covered with a roof or overhang, and equipped with a clarifier or other pretreatment facility; and (2) properly connected to a sanitary sewer.

Outdoor Processing Areas

BMP-26 Outdoor processing areas shall: (1) cover or enclose areas that would be the most significant source of pollutants; or, (2) slope the area toward a dead-end sump; or, (3) discharge to the sanitary sewer system.

BMP-27 Grade or berm processing area to prevent run-on from surrounding areas.

BMP-28 Installation of storm drains in areas of equipment repair is prohibited.

Surface Parking Areas

BMP-29 Where landscaping is proposed in surface parking areas (both covered and uncovered), incorporate landscape areas into the drainage design.

BMP-30 Overflow parking (parking in excess of the project's minimum parking requirements) should be constructed with permeable paving.

Non-Retail Fueling Areas

Non-Retail fueling areas shall be designed with the following:

BMP-31 Fuel dispensing area that is: (1) paved with Portland cement concrete or equivalent smooth impervious surface (asphalt concrete is prohibited); (2) designed to extend 6.5 feet (2.0 meters) from the corner of each fuel dispenser, or the length at which the hose and nozzle assembly may be operated plus 1 foot (0.3 meter), whichever is less; (3) sloped to prevent ponding; (4) separated from the rest of the site by a grade break that prevents run-on of urban runoff; and (5) designed to drain to the project's treatment control BMP(s) prior to discharging to the storm water conveyance system.

BMP-32 Overhanging roof structure or canopy that is: (1) equal to or greater than the area within the fuel dispensing area's grade break; and (2) designed not to drain onto or across the fuel dispensing area.

Steep Hillside Landscaping

BMP-33 Steep hillside areas disturbed by project development shall be landscaped with deep-rooted, drought tolerant plant species selected for erosion control, in accordance with the Landscape Technical Plan.

2.3.3.4 Treatment Control BMPs

Where identified in Table 1, and after LID site design and source control BMPs have been incorporated into the project, priority projects shall include in their design a single or combination of treatment control BMPs designed to infiltrate, filter, and/or treat runoff from the project footprint using one of the “Numeric Sizing Treatment Standards” listed in Table 3, below. Applicants must use the Structural Treatment BMP Selection Procedure outlined in Chapter 2.3.3.5, below to select appropriate treatment control BMPs. Applicants are encouraged to design projects so that runoff is treated by LID site design BMPs, such as rooftop runoff treated in landscaping, so that it may be applied towards the numeric sizing treatment standards, satisfactory to the City Engineer. Treatment efficiencies can also be realized by locating treatment controls strategically within a drainage basin without being limited by the project boundary.

In all instances, structural treatment BMP(s) may be located on- or off-site, used singly or in combination, or shared by multiple new developments, pursuant to the following criteria:

1. All structural treatment control BMPs shall infiltrate, filter, and/or treat the required runoff volume or flow prior to discharging to any receiving water body supporting beneficial uses;
2. Post-construction structural treatment control BMPs for a single priority project shall collectively be designed to comply with the numeric sizing treatment standards;

3. Shared BMPs shall be operational prior to the use of any dependent development or phase of development. The shared BMPs shall only be required to treat the dependent developments or phases of development that are in use;
4. Interim storm water BMPs that provide equivalent or greater treatment than is required may be implemented by a dependent development until each shared BMP is operational. If interim BMPs are selected, the BMPs shall remain in use until permanent BMPs are operational.

Alternatively, a project proponent may elect to implement a combination of LID BMPs that either disperse and infiltrate, or direct to bioretention facilities, the flows from all impervious areas on-site. These BMPs are presumed to provide maximum extent practicable treatment for all pollutants of concern; therefore no further documentation of the treatment BMP selection process is required.

Treatment control BMPs with a high or medium pollutant removal efficiency for the project's most significant pollutant of concern shall be selected. Treatment control BMPs with a low removal efficiency ranking shall only be approved by the Copermittee when a feasibility analysis has been conducted which exhibits that implementation of treatment control BMPs with a high or medium removal efficiency ranking are infeasible.

Treatment control BMPs shall not be constructed within a receiving water.

Table 3
Numeric Sizing Treatment Standards

Volume

1. Volume-based BMPs shall be designed to mitigate (infiltrate, filter, or treat) either:
   - i. The volume of runoff produced from a 85th percentile storm event, as determined from isopluvial maps contained in the County of San Diego Hydrology Plan (0.6 inch approximate average for the San Diego County area) [Note: Applicants may calculate the 85th percentile storm event using local rain data, when available. See the County of San Diego's isopluvial map at http://www.sdcounty.ca.gov/dpw/engineer/flood.htm]; or
   - ii. The volume of runoff produced by the 85th percentile storm event, determined as the maximized capture urban runoff volume for the area, from the formula recommended in *Urban Runoff Quality Management, WEF Plan of Practice No. 23/ ASCE Plan of Practice No. 87, page 175 Equation 5.2; (1998*); or
   - iii. The volume of annual runoff based on unit basin storage volume, to achieve 90 percent or more volume treatment by the method recommended in the latest edition of the *California Stormwater Best Management Practices Handbook,* or
   - iv. The volume of runoff, as determined from the local historical rainfall record, that achieves approximately the same reduction in pollutant loads and flows as achieved by mitigation of the 85th percentile 24-hour runoff event.

OR

Flow

2. Flow-based BMPs shall be designed to mitigate (infiltrate, filter, or treat) either:

3.0 The maximum flow rate of runoff produced from a rainfall intensity of 0.2 inch of rainfall per hour for each hour of a storm event; or

4.0 The maximum flow rate of runoff produced by the 85th percentile hourly rainfall intensity, as determined from the local historical rainfall record, multiplied by a factor of two; or

5.0 The maximum flow rate of runoff, as determined from the local historical rainfall record, that achieves approximately the same reduction in pollutant loads and flows as achieved by mitigation of the 85th percentile hourly rainfall intensity multiplied by a factor of two.

Notes on Structural Treatment Limited Exclusions

Proposed restaurants, where the land area for development or redevelopment is less than 5,000 square feet, are excluded from the numerical sizing criteria requirements listed in Table 3.

Where significant redevelopment results in an increase of less than 50 percent of the impervious surfaces of a previously existing development, and the existing development was not subject to priority project requirements, the numeric sizing criteria apply only to the addition, and not to the entire development.

2.3.3.5 Structural Treatment BMP Selection Procedure

Priority projects shall select a single or combination of treatment BMPs from the categories in Table 4 that maximize pollutant removal for the particular pollutant(s) of concern.

1. Determine if the project would discharge to a Clean Water Act Section 303(d) impaired receiving water. If any receiving waters for the project are impaired, identify the specific type of pollutant(s) for which the receiving water(s) is/are impaired.
2. If the project is anticipated to generate a pollutant (per Table 2) for which the receiving water is impaired, select one or more BMPs from Table 4 that maximize the pollutant removal for that pollutant. Any pollutants the project is expected to generate that are also causing a Clean Water Act section 303(d) impairment of the downstream receiving waters of the project shall be given top priority in selecting treatment BMPs
3. If none of the project's receiving waters are listed as impaired, select one or more BMPs from Table 4 that maximize the removal of the pollutants the project is anticipated to generate.

Alternative storm water BMPs not identified in Table 4 may be approved at the discretion of the City Engineer, provided the alternative BMP is as effective in removal of pollutants of concern as other feasible BMPs listed in Table 4.

Table 4. Structural Treatment Control BMP Selection Matrix

Pollutants of Concern	Bioretention Facilities (LID)	Settling Basins (Dry Ponds)	Wet Ponds and Wetlands	Infiltration Facilities or Practices (LID)	Media Filters	High-rate biofilters	High-rate media filters	Trash Racks & Hydro -dynamic Devices
Coarse Sediment and Trash	High	High	High	High	High	High	High	High
Pollutants that tend to associate with fine particles during treatment	High	High	High	High	High	Medium	Medium	Low
Pollutants that tend to be dissolved following treatment	Medium	Low	Medium	High	Low	Low	Low	Low

2.3.3.6 Notes on Pollutants of Concern

In Table 4 above, Pollutants of Concern are grouped as gross pollutants, pollutants that tend to associate with fine particles, and pollutants that remain dissolved. The table below distinguishes the pollutant types associated with each of these three groupings.

Pollutant	**Coarse Sediment and Trash**	**Pollutants that tend to associate with fine particles during treatment**	**Pollutants that tend to be dissolved following treatment**
Sediment	X	X	
Nutrients		X	X
Heavy Metals		X	
Organic Compounds		X	
Trash & Debris	X		
Oxygen Demanding		X	
Bacteria		X	
Oil & Grease		X	
Pesticides		X	

2.3.3.7 Notes on Treatment Control BMP Categories

All rankings are relative. Ranking of all facilities assumes proper sizing, design, and periodic maintenance. Following are general descriptions of each category.

- **Bioretention Facilities** (infiltration planters, flow-through planters, bioretention areas, and bioretention swales). Facilities are designed to capture runoff and infiltrate slowly through soil media which also supports vegetation. Bioretention facilities, except for flow-through planters, effectively promote infiltration into native soils. In clay soils, facilities may capture excess treated runoff in an underdrain piped to the municipal storm drain system. Typical criteria: an infiltration surface area at least 4% of tributary impervious area, 6-inch average depth of top reservoir, 18-inch soil layer, 12-inch to 18-inch gravel subsurface storage layer.

- **Settling Basins and Wetlands** (extended detention basins, "wet" basins, decorative or recreational lakes or water features also used for stormwater treatment, constructed wetlands). Facilities are designed to capture a minimum water quality volume of 80% of total runoff and detain for a minimum of 48 hours. Some wetland designs have proven effective in removing nutrients, but performance varies.

- **Infiltration Facilities or Practices** (infiltration basins, infiltration trenches, dry wells, dispersal of runoff to landscape, pervious pavements). These facilities and landscape designs capture, retain, and infiltrate a minimum of 80% of runoff into the ground. Infiltration facilities are generally only feasible in permeable (Hydrologic Soil Group A or B) soils. Volume and area of infiltration facilities depends on soil permeability and safety factor used. Typical criteria: Infiltration facilities should have pretreatment to remove silt to prolong life of the facility. A 10-foot vertical separation from average seasonal groundwater depth is required. Dispersal of runoff to landscape may be accomplished in any soil type and generally requires a maximum 2:1 ratio impervious:pervious and concave topography to ensure the first 1 inch of rainfall is retained.

- **Media Filters** (sand filters). Filters designed to treat runoff produced by a rainfall of 0.2 inches per hour (or 2×85^{th} percentile hourly rainfall intensity) by slow infiltration through sand or other media. Typical criteria: Surface loading rate not to exceed 5 inches/hour. Entire surface of the sand must be accessible for maintenance.

- **High Rate Biofilters** (tree wells, typically proprietary). Biofilters with specially designed media to rapidly filter runoff while removing some pollutants. Some proprietary biofilter systems recommend surface loading rates of up to 100 inches/hour.

- **High-rate Media Filters** (typically proprietary). Vaults with replaceable cartridge filters filled with inorganic media.

- **Drainage Inserts** have low effectiveness in removing pollutants that tend to associate with fine particles and have medium effectiveness in removing coarse sediment and trash. They are sometimes used to augment more effective treatment facilities and are sometimes used alone when more effective facilities have been deemed infeasible.

2.3.3.8 Restrictions on the Use of Infiltration Treatment BMPs

Treatment control BMPs that are designed to primarily function as infiltration devices shall meet the following conditions (these conditions do not apply to treatment BMPs which allow incidental infiltration and are not designed to primarily function as infiltration devices, such as grassy swales, detention basins, vegetated buffer strips, constructed wetlands, etc.): (1) urban runoff from commercial developments shall undergo pretreatment to remove both physical and chemical contaminants, such as sedimentation or filtration, prior to infiltration; (2) all dry weather flows shall be diverted from infiltration devices except for those non-storm water discharges authorized pursuant to 40 CFR 122.26(d)(2)(iv)(B)(1): diverted stream flows, rising ground waters, uncontaminated ground water infiltration [as defined at 40 CFR 35.2005(20)] to storm water conveyance systems, uncontaminated pumped ground water, foundation drains, springs, water from crawl space pumps, footing drains, air conditioning condensation, flow from riparian habitats and wetlands, water line flushing, landscape irrigation, discharges from potable water sources other than water main breaks, irrigation water, individual residential car washing, and dechlorinated swimming pool discharges; (3) pollution prevention and source control BMPs shall be implemented at a level appropriate to protect groundwater quality at sites where infiltration structural treatment BMPs are to be used; (4) the vertical distance from the base of any infiltration structural treatment BMP to the seasonal high groundwater mark shall be at least 10 feet. Where groundwater does not support beneficial uses, this vertical distance criterion may be reduced, provided groundwater quality is maintained; (5) the soil

through which infiltration is to occur shall have physical and chemical characteristics that are adequate for proper infiltration durations and treatment of urban runoff for the protection of groundwater beneficial uses[3]; (6) the horizontal distance between the base of any infiltration structural BMP and any water supply wells shall be 100 feet or as determined appropriate by the City Engineer.

Notification to neighboring jurisdictions may be required where staff determines the infiltration BMP(s) may impact the groundwater in a neighboring jurisdiction.

[3] Soils at infiltration sites must have the following properties: Organic Content (OC) > 5%, pH between 6-8, Cation exchange capacity (CEC) > 5 meq/100g soil, in drill-hole conductivity valve of 0.5 in/hr or greater.

2.4 IMPLEMENTATION AND MAINTENANCE REQIUREMENTS

2.4.1 Introduction

After all project BMPs have been approved by the City Engineer, applicants must ensure implementation and maintenance of the BMPs according to the processes outlined in the applicable chapters for projects requesting discretionary actions and/or construction permits. In addition, any project that will require a "General NPDES Permit for Storm Water Discharges Associated with Industrial Activities," shall include the following note on the plans and condition in the permit/approval:

"Industrial NPDES Permit Requirement
The Permittee or designee shall provide evidence of coverage under the General Industrial National Pollutant Discharge Elimination System Permit in the form of a Notice of Intent (NOI) filed with the State Water Resources Control Board prior to the issuance of any construction permits."

2.4.2 Discretionary Actions

Projects that include permanent BMPs shall be conditioned to require the applicant or designee to execute a maintenance agreement for ongoing permanent BMP maintenance in accordance with the program outlined in the "Permanent Storm Water BMP Maintenance Agreement Requirements" below, satisfactory to the City Engineer, prior to the issuance of any construction permits. This requirement shall be noted on the plans for the discretionary action. The permanent BMPs shall be graphically shown on the plans, where possible, and made a condition of the project's permit/approval.

2.4.3 Requirements of Plan

The City has adopted an approach for ensuring verification that all permanent post construction BMPs are constructed per the requirements of the approved plans. To ensure that all permanent post construction BMPs for a particular project are installed/constructed at the conclusion of the project, the City requires developer preparation of a single plan BMP sheet as part of the plan submittals.

The single plan BMP sheet will include a site plan of the project calling out the location of each required LID site design, source control and treatment control BMP. In addition, the plan will contain a matrix listing of the required BMPs cross referenced with a list of the specific construction drawing sheet where the specified BMP construction is detailed. A copy of the single plan BMP sheet will be attached to each construction drawing set (building, mass grading, finished grading, improvements, and grading) highlighting the BMPs.

At a minimum, the plan sheet will have the following information included:

1) Entire property on one map
2) Drainage areas/direction of flows
3) Private storm drain systems
4) Nearby waterbodies
5) Location of storm drain conveyance systems
6) Location of proposed stormwater controls and BMPs, including detention basins
7) Locations of impervious and pervious areas (hatched)
8) Location where materials would be exposed to stormwater (hatched)
9) Areas of potential erosion (hatched)
10) All site design and source control BMPs shown, detailed and/or listed in the General Notes on BMP Plan Sheet
11) All treatment control BMPs shown, detailed and called out on the plan sheet
12) Delineated areas draining to each treatment control BMP
13) Call out the 85th percentile discharge rates that are tributary to each entry point of the treatment control BMPs
14) Call out the pollutant types that are expected at each treatment control BMP
15) Signature Block for City Engineer
16) Inspection Signature Blocks for Building, Landscape and Engineering Inspectors

2.4.4 Permanent BMP Maintenance Agreement Requirements

Applicants shall propose a maintenance agreement assuring all permanent BMPs will be maintained throughout the "use" of a project site, satisfactory to the City Engineer (see Appendix E for a list of potential mechanisms). For projects with discretionary actions, the project's permit shall be conditioned to require the applicant or designee to execute a maintenance agreement for ongoing permanent BMP maintenance, satisfactory to the City Engineer, prior to the issuance of any construction permits. This requirement shall be noted on the plans for the discretionary action. City-approved method of permanent BMP maintenance shall be incorporated into, and shall be consistent with permits issued by resource agencies, before decision-maker approval of discretionary actions. In all instances, the applicant shall provide proof of execution of a City-approved method of permanent BMP maintenance repair and replacement before the issuance of construction approvals.

The maintenance agreement shall include the following:

1. Operation & Maintenance (O&M) Plan: The applicant shall include an Operation & Maintenance (O&M) plan, prepared satisfactory to the City Engineer, with the approved maintenance agreement The O&M Plan shall describe the designated responsible party to manage the storm water BMP(s), employee's training program and duties, operating schedule, maintenance frequency, routine service schedule, specific maintenance activities (including maintenance of storm water conveyance system stamps), copies of resource agency permits, and any other necessary activities. At a minimum, maintenance agreements shall require the property owner or other responsible party to provide inspection and servicing of all permanent treatment BMPs on an annual basis. The property owner, responsible party or City-approved maintenance entity shall complete and maintain O&M forms to document all maintenance requirements. Parties responsible for the O&M plan shall retain records for at least 5 years. These documents shall be made available to the City for inspection upon request at any time.

2. Access Easement/Agreement: The applicant shall execute an access easement to the City of Carlsbad that shall be binding on the land throughout the life of the project, until such time that the permanent treatment BMP requiring access is no longer required to be in use, satisfactory to the City. This access easement may be necessary in the event that the property owner does not adequately maintain the permanent stormwater BMP and the City has to temporarily step in to perform needed maintenance of the BMP.This easement requirement may be incorporated into the provisions of the "Permanent Storm Water BMP Maintenance Agreement".

APPENDIX A

STORM WATER STANDARDS QUESTIONNAIRE

INSTRUCTIONS:

This questionnaire must be completed by the applicant in advance of submitting for a development application (subdivision and land use planning approvals and construction permits). The results of the questionnaire determine the level of storm water pollution prevention standards applied to a proposed development or redevelopment project. Many aspects of project site design are dependent upon the storm water pollution protection standards applied to a project.

Applicant responses to the questionnaire represent an initial assessment of the proposed project conditions and impacts. City staff has responsibility for making the final assessment after submission of the development application. A staff determination that the development application is subject to more stringent storm water standards, than initially assessed by the applicant, will result in the return of the development application as incomplete.

If applicants are unsure about the meaning of a question or need help in determining how to respond to one or more of the questions, they are advised to seek assistance from Engineering Department Development Services staff.

A separate completed and signed questionnaire must be submitted for each new development application submission. Only one completed and signed questionnaire is required when multiple development applications for the same project are submitted concurrently. In addition to this questionnaire, applicants for construction permits must also complete, sign and submit a Construction Activity Storm Water Standards Questionnaire.

To address pollutants that may be generated from new development, the City requires that new development and significant redevelopment priority projects incorporate Permanent Storm Water Best Management Practices (BMPs) into the project design, which are described in Chapter 2 of the City's Storm Water Standards Manual This questionnaire should be used to categorize new development and significant redevelopment projects as priority or non-priority, to determine what level of storm water standards are required or if the project is exempt.

*1. Is your project a **significant redevelopment**?*

Definition:

***Significant redevelopment** is defined as the creation, addition or replacement of at least 5,000 square feet of impervious surface on an already existing developed site.*

***Significant redevelopment** includes, but is not limited to: the expansion of a building footprint; addition to or replacement of a structure; structural development including an increase in gross floor area and/or exterior construction remodeling; replacement of an impervious surface that is not part of a routine maintenance activity; and land disturbing activities related with structural or impervious surfaces. Replacement of impervious surfaces includes any activity that is not part of a routine maintenance activity where impervious material(s) are removed, exposing underlying soil during construction.*

Note: If the Significant Redevelopment results in an increase of less than fifty percent of the impervious surfaces of a previously existing development, and the existing development was not subject to SUSMP requirements, the numeric sizing criteria discussed in Table 3 of 2.3.3.4 applies only to the addition, and not to the entire development.

2. *If your project **IS** considered significant redevelopment, then please skip Section 1 and proceed with Section 2.*
3. *If your project **IS NOT** considered significant redevelopment, then please proceed to Section 1.*

SECTION 1

NEW DEVELOPMENT

PRIORITY PROJECT TYPE **Does you project meet one or more of the following criteria:**	**YES**	**NO**
1. *Home subdivision of 100 units or more.* Includes SFD, MFD, Condominium and Apartments		
2. *Residential development of 10 units or more.* Includes SFD, MFD, Condominium and Apartments		
3. *Commercial and industrial development greater than 100,000 square feet including parking areas.* Any development on private land that is not for heavy industrial or residential uses. Example: Hospitals, Hotels, Recreational Facilities, Shopping Malls, etc.		
4. *Heavy Industrial / Industry greater than 1 acre* (NEED SIC CODES FOR PERMIT BUSINESS TYPES) SIC codes 5013, 5014, 5541, 7532-7534, and 7536-7539		
5. *Automotive repair shop.* SIC codes 5013, 5014, 5541, 7532-7534, and 7536-7539		
6. *A New Restaurant where the land area of development is 5,000 square feet or more including parking areas.* SIC code 5812		
7. *Hillside development* (1) greater than 5,000 square feet of impervious surface area and (2) development will grade on any natural slope that is 25% or greater		
8. *Environmentally Sensitive Area (ESA).* Impervious surface of 2,500 square feet or more located within, "directly adjacent"[2] to (within 200 feet), or "discharging directly to"[3] receiving water within the ESA[1]		
9. *Parking lot.* Area of 5,000 square feet or more, or with 15 or more parking spaces, and potentially exposed to urban runoff		
10. *Retail Gasoline Outlets – serving more than 100 vehicles per day* Serving more than 100 vehicles per day and greater than 5,000 square feet		
11. *Streets, roads, driveways, highways, and freeways.* Project would create a new paved surface that is 5,000 square feet or greater.		
12. *Coastal Development Zone.* Within 200 feet of the Pacific Ocean and (1) creates more than 2500 square feet of impermeable surface or (2) increases impermeable surface on property by more than 10%.		

1 Environmentally Sensitive Areas include but are not limited to all Clean Water Act Section 303(d) impaired water bodies; areas designated as Areas of Special Biological Significance by the State Water Resources Control Board (Water Quality Control Plan for the San Diego Basin (1994) and amendments); water bodies designated with the RARE beneficial use by the State Water Resources Control Board (Water Quality Control Plan for the San Diego Basin (1994) and amendments); areas designated as preserves or their equivalent under the Multi Species Conservation Program within the Cities and Count of San Diego; and any other equivalent environmentally sensitive areas which have been identified by the Copermittees.

2 "Directly adjacent" means situated within 200 feet of the environmentally sensitive area.

3 "Discharging directly to" means outflow from a drainage conveyance system that is composed entirely of flows from the subject development or redevelopment site, and not commingled with flow from adjacent lands.

Section 1 Results:

If you answered **YES** to **ANY** of the questions above you have a **PRIORITY** project and **PRIORITY** project requirements **DO** apply. A Storm Water Management Plan, prepared in accordance with City Storm Water Standards, must be submitted at time of application. Please check the "MEETS PRIORITY REQUIREMENTS" box in Section 3.

If you answered **NO** to **ALL** of the questions above, then you are a **NON-PRIORITY** project and **STANDARD** requirements apply. Please check the "DOES NOT MEET PRIORITY Requirements" box in Section 3.

SECTION 2

SIGNIFICANT REDEVELOPMENT:	YES	NO
1. Is the project redeveloping an existing priority project type? (Priority projects are defined in Section 1)		
If you answered **YES**, please proceed to question 2. If you answered **NO**, then you **ARE NOT a** significant redevelopment and you **ARE NOT** subject to **PRIORITY** project requirements, only **STANDARD** requirements. Please check the "DOES NOT MEET PRIORITY Requirements" box in Section 3 below.		
2. Is the project solely limited to one of the following:		
a. Trenching and resurfacing associated with utility work?		
b. Resurfacing and reconfiguring existing surface parking lots?		
c. New sidewalk construction, pedestrian ramps, or bike lane on public and/or private existing roads?		
d. Replacement of existing damaged pavement?		
If you answered **NO** to **ALL** of the questions, then proceed to Question 3. If you answered **YES** to **ONE OR MORE** of the questions then you **ARE NOT** a significant redevelopment and you **ARE NOT** subject to **PRIORITY** project requirements, only **STANDARD** requirements. Please check the "DOES NOT MEET PRIORITY Requirements" box in Section 3 below.		
3. Will the development create, replace, or add at least 5,000 square feet of impervious surfaces on an existing development or, be located within 200 feet of the Pacific Ocean and (1)create more than 2500 square feet of impermeable surface or (2) increases impermeable surface on property by more than 10%?		
If you answered **YES**, you **ARE** a significant redevelopment, and you **ARE** subject to **PRIORITY** project requirements. Please check the "MEETS PRIORITY REQUIREMENTS" box in Section 3 below. If you answered **NO**, you **ARE NOT** a significant redevelopment, and you **ARE NOT** subject to **PRIORITY** project requirements, only **STANDARD** requirements. Please check the "DOES NOT MEET PRIORITY Requirements" box in Section 3 below.		

SECTION 3

Questionnaire Results:

- ❑ MY PROJECT **MEETS PRIORITY REQUIREMENTS,** MUST COMPLY WITH PRIORITY PROJECT STANDARDS AND MUST PREPARE A STORM WATER MANAGEMENT PLAN FOR SUBMITTAL AT TIME OF APPLICATION**.**
- ❑ MY PROJECT **DOES NOT MEET PRIORITY REQUIREMENTS** AND MUST ONLY COMPLY WITH STANDARD STORM WATER REQUIREMENTS.

Applicant Information and Signature Box

Address:	Assessors Parcel Number(s):
Applicant Name:	Applicant Title:
Applicant Signature:	Date:

This Box for City Use Only

City Concurrence:	YES	NO
By:		
Date:		
Project ID:		

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APPENDIX B

EXAMPLE PERMANENT STORM WATER BEST MANAGEMENT PRACTICES

The following are a list of BMPs that may be used to minimize the introduction of pollutants of concern that may result in significant impacts to receiving waters. Other BMPs approved by the Development Services Department as being equal or more effective in pollutant reduction than comparable BMPs identified below are acceptable. All BMPs must comply with local zoning and building codes and other applicable regulations.

LID Site Design BMPs

Minimizing Impervious Areas.
Reduce sidewalk widths.
Incorporate landscaped buffer areas between sidewalks and streets.
Design residential streets for the minimum required pavement widths.
Minimize the number of residential street cul-de-sacs and incorporate landscaped areas within cul-de-sac centers with curb-cuts to reduce their impervious cover.
Use open space development that incorporates smaller lot sizes.
Increase building density while decreasing the building footprint.
Reduce overall lot imperviousness by promoting alternative driveway surfaces and shared driveways that connect two or more homes together.
Reduce overall imperviousness associated with parking lots by providing compact car spaces, minimizing stall dimensions, incorporating efficient parking lanes, and using pervious materials in spillover parking areas.
Increase Rainfall Infiltration.
Use permeable materials for private sidewalks, driveways, parking lots, and interior roadway surfaces (examples: hybrid lots, parking groves, permeable overflow parking, etc.).
Use curb-cuts to direct pavement runoff into swales, landscaping, and natural areas prior to entering the MS4.
Direct rooftop runoff to pervious areas such as yards, open channels, or vegetated areas, and avoid routing rooftop runoff to the roadway or the urban runoff conveyance system.
Pitch driveways and parking areas toward yards and vegetated areas prior to draining into the MS4.
Conserve and utilize natural soils and/or use amended soils to encourage light infiltration/ percolation.
Minimize disturbances to natural drainages
Minimize soil compaction in planned green space (landscaped areas, lawns, etc.) and re-till soils when compacted by grading/construction equipment.
Maximize Rainfall Interception.
Maximizing canopy interception and water conservation by preserving existing native trees and shrubs, and planting additional native or drought tolerant trees and large shrubs.
Cisterns / Rain barrels.
Foundation landscaping.

Minimize Directly Connected Impervious Areas (DCIAs):
Draining rooftops into adjacent landscaping prior to discharging to the storm drain.
Use curb-cuts to allow parking lots to drain into landscape areas co-designed as biofiltration areas and/or swales prior to draining into the MS4.
Draining roads, sidewalks, and impervious trails into adjacent landscaping.
Slope and Channel Protection.
Use of natural drainage systems to the maximum extent practicable.
Stabilized permanent channel crossings.
Planting native or drought tolerant vegetation on slopes.
Energy dissipaters, such as riprap, at the outlets of new storm drains, culverts, conduits, or channels that enter unlined channels.

Source Control BMPs
Storm drain system stenciling and signage
Outdoor material and trash storage area designed to reduce or control rainfall runoff
Efficient irrigation system

Treatment Control BMPs
Biofilters
Bioretention Swale (detains and infiltrates water through soil)
Stormwater Planter Box (open-bottomed)
Stormwater Flow-Through Planter (sealed bottom)
Vegetated filter strip
Bioretention Area
Vegetated / Rock SwaleVegetated filterVegetated Roofs / Modules / Walls
Detention Basins
Extended/dry detention basin with grass / vegetated lining
Extended/dry detention basin with impervious lining

Infiltration Facilities
Infiltration basin
Infiltration trench
Dry well
Permeable Paving
Gravel
Permeable asphalt
Pervious concrete
UnitPermeable unit pavers, ungrouted, set on sand or gravel
Subsurface Reservoir Bed

Wet Ponds and Wetlands
Wet pond (permanent pool)
Constructed wetland

Filtration Systems
Media filtration
Sand filtration

Hydrodynamic Separation Systems
Swirl Concentrator
Cyclone Separator

Trash Racks and Screens

APPENDIX C

STORM WATER MANAGEMENT PLAN GUIDELINES

Purpose
To describe the permanent storm water Best Management Practices (BMPs) that will be incorporated in the project to mitigate the impacts of urban runoff due to the development.

Minimum SWMP Requirements
The Storm Water Management Plan and Drainage Study Report shall be prepared, amended and certified by a Qualified SWMP Preparer. The City staff may be able to provide resources for example SWMPs or SWMP templates.

Qualified SWMP Preparer
A Qualified SWMP Preparer shall have one of the following registrations or certifications:

1. A California registered civil engineer,
2. A California registered geologist,
3. A California registered landscape architect,
4. A professional hydrologist registered through the American Institute of Hydrology,
5. A certified professional soil scientist registered through the Soil Science Society of America,
6. A certified professional in erosion and sediment control registered through Certified Professional in Erosion and Sediment Control, Inc.,
7. A certified professional in storm water quality registered through Certified Professional in Erosion and Sediment Control, Inc., or
8. A certified professional in erosion and sediment control registered through the National Institute for Certification in Engineering Technologies.

Any hydrology or hydraulic calculations, soils reports or geotechnical reports prepared in support of a SWMP must be prepared by a professional engineer with appropriate registration qualifications issued by the State of California.

The City Engineer may approve alternative means for establishing the certification of a Qualified SWMP Preparer upon submittal of a letter by the project proponent requesting approval of an alternative certification and presenting due cause why such alternative certification should be considered.

<u>SWMP Organization & Content</u>

1. Table of Contents

2. Vicinity Map

3. Project Description
   - ❑ Narrative of project activities

4. Site Map
   - ❑ Entire property included on one map (use key map if multi-sheets)
   - ❑ Drainage areas/direction of flows
   - ❑ Private storm drain systems

- ❑ Nearby water bodies and municipal storm drain inlets
- ❑ Location of storm drain conveyance systems
- ❑ Location of proposed stormwater controls and BMPs, including detention basins
- ❑ Locations of impervious and pervious areas (hatched)
- ❑ Location where materials would be exposed to stormwater (hatched)
- ❑ Areas of potential erosion (hatched)
- ❑ Location of building and activity areas (e.g. fueling islands, garages, waste container area, wash racks, hazardous material storage areas, etc.)
- ❑ All site design and source control BMPs shown, detailed and/or listed in the General Notes on BMP Plan Sheet
- ❑ All treatment control BMPs shown, detailed and called out on the plan sheet
- ❑ Delineated areas draining to each treatment control BMP
- ❑ Call out the 85th percentile discharge rates that are tributary to each entry point of the treatment control BMPs
- ❑ Call out the pollutant types that are expected at each treatment control BMP
- ❑ Signature Block for City Engineer
- ❑ Inspection Signature Blocks for Building, Landscape and Engineering Inspectors

5. Identify Pollutants of Concern in Receiving Waters
   - ❑ Identify anticipated pollutants from project area in accordance with Chapter 3.1.1. of this document
   - ❑ Identify receiving waters, watershed and hydrologic unit basin number
   - ❑ Identify impaired water bodies downstream of the project and impairment
   - ❑ Identify primary pollutants of concern
   - ❑ Provide Drainage Study Report in accordance with Chapter 3.1.3. of this document

6. Identify Conditions of Concern
   - ❑ Provide Drainage Study Report
   - ❑ Identify conditions of concern
   - ❑ Provide runoff calculations

7. Identify LID Site Design BMPs
   - ❑ Maintain pre-development rainfall runoff characteristics
   - ❑ Protect slopes and channels

8. Identify Source Control BMPs
   - ❑ Materials Storage
   - ❑ Trash storage
   - ❑ IPM
   - ❑ Efficient irrigation and landscape design
   - ❑ Inlet stenciling and signage
   - ❑ Other controls (as applicable)

9. BMPs for individual Priority Project Categories (as applicable)
   - ❑ Private road
   - ❑ Residential driveways and guest parking
   - ❑ Dock areas
   - ❑ Maintenance bays
   - ❑ Vehicle wash areas
   - ❑ Outdoor processing areas
   - ❑ Surface parking areas
   - ❑ Non-retail fueling areas
   - ❑ Steep hillside landscaping

10. Identify Structural Treatment Control BMPs
    - ❑ Design criteria (include calculations)

- ❑ Basis for selection (include targeted pollutants, justification, and alternative analysis)
- ❑ Pollutant removal information (other than vendor specifications)
- ❑ Restrictions, if appropriate
- ❑ Location of BMPs
- ❑ Literature References

11. BMP Maintenance Provisions
    - ❑ Party that will be responsible for maintenance (Name, address and phone number)
    - ❑ Recommended maintenance frequency
    - ❑ Maintenance instructions for each BMP type included
    - ❑ Adequate access and room for maintenance equipment provided
    - ❑ BMP Maintenance Agreement referenced

CITY OF CARLSBAD
STORM WATER MANAGEMENT PLAN (SWMP)
SUBMITTAL REQUIREMENTS CHECKLIST

PROJECT: _____ DATE OF REPORT: _____
REVIEWED BY: _____ DATE REVIEWED: _____
PRELIMINARY REVIEW: _____ FINAL REVIEW: _____

No.	Requirement	Applicable? (Y/N)	Addressed? (Y/N)	Comment
	Prepared by a Qualified SWMP Preparer	Y		
1.	**Table of Contents**	Y		
2.	**Vicinity Map**	Y		
3.	**Project Description**	Y		
4.	**Single BMP Plan Sheet as described in Chapter 2.4.3**	Y		
	Entire property on one map	Y		
	Drainage areas/direction of flow	Y		
	Private storm drain systems	Y		
	Nearby water bodies/municipal storm drain inlets	Y		
	Location of storm water conveyance systems	Y		
	Location of existing/proposed storm water controls and BMPs	Y		
	Location of impervious areas	Y		
	Location where materials would be exposed to storm water	Y		
	Location of building and activity areas	Y		
	Areas of potential soil erosion	Y		
5.	**Identification of Pollutants of Concern (POCs)**	Y		
	Identification of pollutants from the project area	Y		
	Identification of receiving waters	Y		
	Identification of watershed and hydrologic unit basin number	Y		
	Identification of 303(d) listed receiving waters	Y		
	Identification of primary and secondary pollutants of concern	Y		
6.	**Identification of Conditions of Concern (COCs)**	Y		
	Drainage Study Report	Y		
	Identification of Conditions of Concern	Y		
	Runoff calculations	Y		
7.	**Identify LID Site Design BMPs**	Y		
	Maintain pre-development rainfall runoff characteristics	Y		

No.	Requirement	Applicable? (Y/N)	Addressed? (Y/N)	Comment
	Protect slopes and channels	Y		
8.	**Identify Source Control BMPs**	Y		
	Outdoor material storage areas			
	Trash storage areas			
	IPM – Integrated Pest Management Program			
	Efficient irrigation systems and landscape design			
	Storm drain system stenciling and signage			
9.	**BMPs for Individual Priority Project Categories**	Y		
	Private roads			
	Residential driveways and guest parking			
	Dock areas			
	Maintenance bays			
	Vehicle wash areas			
	Outdoor processing areas			
	Surface Parking Areas			
	Non-retail fueling areas			
	Steep Hillside landscaping			
10.	**Treatment Control BMPs**			
	LEAD method proposed?			
	Numeric sizing standards (design criteria)			
	Treatment Control BMP selection (include target pollutants, justification and alternative analysis)			
	Pollutant removal information (in addition to vendor specifications)			
	Restrictions on use of infiltration BMPs			
	Location of treatment control BMPs			
	Structural Treatment Limited Exclusion?			
	Literature references			
11.	**Storm Water BMP Maintenance**	Y		
General Comments:				
NA – Not applicable (no revision is required) Revisions to the SWMP are required for all those requirements listed in this table as applicable, but identified as not addressed with an N.				

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APPENDIX D

SUGGESTED RESOURCES	HOW TO GET A COPY
The County of San Diego Low Impact Development Handbook; Stormwater Management Strategies (2007) Presents guidance for LID stormwater planning and management techniques. Fact Sheets on LID BMPs are provided in the Appendices.	The County of San Diego The Department of Planning and Land Use 5201 Ruffin Road, Suite B San Diego, CA 92123 http://www.sdcounty.ca.gov/dplu/LID_PR.html www.sdcounty.ca.gov/dplu/
Better Site Design: A Handbook for Changing Development Rules in Your Community (1998) Presents guidance for different model development alternatives.	Center for Watershed Protection 8391 Main Street Ellicott City, MD 21043 410-461-8323 www.cwp.org
California Urban runoff Best Management Practices Handbooks (2003) for Construction Activity, Municipal, and Industrial/Commercial Presents a description of a large variety of Structural BMPs, Treatment Control, BMPs and Source Control BMPs	Los Angeles County Department of Public Works Cashiers Office 900 S. Fremont Avenue Alhambra, CA 91803 626-458-6959 www.cabmphandbooks.org
Caltrans Urban runoff Quality Handbook: Planning and Design Staff Guide (Best Management Practices Handbooks (1998) Presents guidance for design of urban runoff BMPs	California Department of Transportation P.O. Box 942874 Sacramento, CA 94274-0001 916-653-2975
Bioretention Plan (updated 2002) Presents guidance for designing, building, and maintaining bioretention facilities.	Prince George's County Watershed Protection Branch 9400 Peppercorn Place, Suite 600 Landover, MD 20785 http://www.co.pg.md.us/Government/AgencyIndex/DER/ESD/Bioretention/bioretention.asp
Contra Costa Clean Water Program Stormwater C.3 Guidebook Includes an integrated design approach to meet California Stormwater NPDES treatment and hydrograph modification management requirements using Low Impact Development site design techniques and facilities.	Contra Costa Clean Water Program 255 Glacier Drive Martinez, CA 94553 www.cccleanwater.org/construction/nd.php
Design of Stormwater Filtering Systems (1996) by Richard A. Claytor and Thomas R. Schuler Presents detailed engineering guidance on ten different urban runoff-filtering systems.	Center for Watershed Protection 8391 Main Street Ellicott City, MD 21043 410-461-8323
Development Planning for Stormwater Management, A Plan for the Standard Urban Stormwater Mitigation Plan (SUSMP), (May 2000)	Los Angeles County Department of Public Works http://dpw.co.la.ca.us/epd/ or http://www.888cleanLA.com
Florida Development Plan: A Guide to Sound Land and Water Management (1988) Presents detailed guidance for designing BMPs	Florida Department of the Environment 2600 Blairstone Road, Mail Station 3570 Tallahassee, FL 32399 850-921-9472

SUGGESTED RESOURCES	HOW TO GET A COPY
Guidance Specifying Management Measures for Sources of Nonpoint Pollution in Coastal Waters (1993) Report No. EPA–840-B-92-002. Provides an overview of, planning and design considerations, programmatic and regulatory aspects, maintenance considerations, and costs.	National Technical Information Service U.S. Department of Commerce Springfield, VA 22161 800-553-6847
Guide for BMP Selection in Urban Developed Areas (2001)	ASCE Envir. and Water Res. Inst. 1801 Alexander Bell Dr. Reston, VA 20191-4400 (800) 548-2723
Low-Impact Development Design Strategies - An Integrated Design Approach (June 1999)	Prince George's County, Maryland Department of Environmental Resource Programs and Planning Division 9400 Peppercorn Place Largo, Maryland 20774 http://www.co.pg.md.us/Government/DER/PPD/pgcounty/lidmain.htm
Maryland Stormwater Design Plan (1999) Presents guidance for designing urban runoff BMPs	Maryland Department of the Environment 2500 Broening Highway Baltimore, MD 21224 410-631-3000
National Stormwater Best Management Practices (BMP) Database, Version 1.0 Provides data on performance and evaluation of urban runoff BMPs	American Society of Civil Engineers 1801 Alexander Bell Drive Reston, VA 20191 703-296-6000
National Stormwater Best Management Practices Database (2001)	Urban Water Resources Research Council of ASCE Wright Water Engineers, Inc. (303) 480-1700
Operation, Maintenance and Management of Stormwater Management (1997) Provides a thorough look at storm water practices including, planning and design considerations, programmatic and regulatory aspects, maintenance considerations, and costs.	Watershed Management Institute, Inc. 410 White Oak Drive Crawfordville, FL 32327 850-926-5310
Portland Stormwater Management Plan (2004) Includes design illustrations and criteria for bioretention facilities.	Environmental Services 1120 SW 5th Ave., Rm. 1000 Portland, OR 97204 503-823-7740 http://www.portlandonline.com/bes/index.cfm?c=35122&
Potential Groundwater Contamination from Intentional and Non-Intentional Stormwater Infiltration	Report No. EPA/600/R-94/051, USEPA (1994).
Preliminary Data Summary of Urban runoff Best Management Practices (August 1999) EPA-821-R-99-012	http://www.epa.gov/ost/stormwater/

SUGGESTED RESOURCES	HOW TO GET A COPY
Reference Guide for Stormwater Best Management Practices (July 2000)	City of Los Angeles Urban runoff Management Division 650 South Spring Street, 7th Floor Los Angeles, California 90014 http://www.lacity.org/san/swmd/
Second Nature: Adapting LA's Landscape for Sustainable Living (1999) by Tree People Detailed discussion of BMP designs presented to conserve water, improve water quality, and achieve flood protection.	Tree People 12601 Mullholland Drive Beverly Hills, CA 90210 (818) 623-4848 Fax (818) 753-4625
Start at the Source (1999) Detailed discussion of permeable pavements and alternative driveway designs presented.	Bay Area Stormwater Management Agencies Association 2101 Webster Street Suite 500 Oakland, CA 510-286-1255 www.basmaa.org
Stormwater Management in Washington State (1999) Vols. 1-5 Presents detailed guidance on BMP design for new development and construction.	Department of Printing State of Washington Department of Ecology P.O. Box 798 Olympia, WA 98507-0798 360-407-7529
Stormwater, Grading and Drainage Control Code, Seattle Municipal Code Section 22.800-22.808, and Director's Rules, Volumes 1-4. (Ordinance 119965, effective July 5, 2000)	City of Seattle Department of Design, Construction & Land Use 700 5th Avenue, Suite 1900 Seattle, WA 98104-5070 (206) 684-8880 http://www.ci.seattle.wa.us/dclu/Codes/sgdccode.htm
Texas Nonpoint Source Book – Online Module (1998)www.txnpsbook.org Presents BMP design and guidance information on-line	Texas Statewide Urban runoff Quality Task Force North Central Texas Council of Governments 616 Six Flags Drive Arlington, TX 76005 817-695-9150
The Practice of Watershed Protection by Thomas R. Shchuler and Heather K. Holland	Center for Watershed Protection 8391 Main Street Ellicott City, MD 21043 410-461-8323 www.cwp.org
Urban Storm Drainage, Criteria Plan – Volume 3, Best Management Practices (1999) Presents guidance for designing BMPs	Urban Drainage and Flood Control District 2480 West 26th Avenue, Suite 156-B Denver, CO 80211 303-455-6277

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APPENDIX E

POTENTIAL PERMANENT TREATMENT BMP MAINTENANCE MECHANISMS

1. Project proponent agreement to maintain storm water BMPs: The City may enter into a contract with the project proponent obliging the project proponent to maintain, repair and replace the storm water BMP as necessary into perpetuity. Security may be required.
2. Assessment districts: The City may approve an Assessment District or other funding mechanism created by the project proponent to provide funds for storm water BMP maintenance, repair and replacement on an ongoing basis. Any agreement with such a District shall be subject to the Public Entity Maintenance Provisions above.
3. Lease provisions: In those cases where the City holds title to the land in question, and the land is being leased to another party for private or public use, the City may assure storm water BMP maintenance, repair and replacement through conditions in the lease.
4. Public entity maintenance: The City may approve a public or acceptable quasi-public entity (e.g., the County Flood Control District, or annex to an existing assessment district, an existing utility district, a state or federal resource agency, or a conservation conservancy) to assume responsibility for maintenance, repair and replacement of the permanent treatment BMP. Unless acceptable to the City, public entity maintenance agreements shall ensure estimated costs are front-funded or reliably guaranteed, (e.g., through a trust fund, assessment district fees, bond, letter of credit or similar means). In addition, the City may seek protection from liability by appropriate releases and indemnities. The City shall have the authority to approve storm water BMPs proposed for transfer to any other public entity within its jurisdiction before installation. The City shall be involved in the negotiation of maintenance requirements with any other public entities accepting maintenance responsibilities within their respective jurisdictions; and in negotiations with the resource agencies responsible for issuing permits for the construction and/or maintenance of the facilities. The City must be identified as a third party beneficiary empowered to enforce any such maintenance agreement within their respective jurisdictions.

The City may accept alternative maintenance mechanisms if such mechanisms are as protective as those listed above.

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APPENDIX F

DEFINITIONS

"Attached Residential Development" means any development that provides 10 or more residential units that share an interior/exterior wall. This category includes, but is not limited to: dormitories, condominiums and apartments.

"Automotive Repair Shop" means a facility that is categorized in any one of the following Standard Industrial Classification (SIC) codes: 5013, 5014, 5541, 7532-7534, or 7536-7539.

"Commercial Development" means any development on private land that is not exclusively heavy industrial or residential uses. The category includes, but is not limited to: mini-malls and other business complexes, shopping malls, hotels, office buildings, public warehouses, hospitals, laboratories and other medical facilities, educational institutions, recreational facilities, plant nurseries, car wash facilities, automotive dealerships, commercial airfields, and other light industrial complexes.

"Commercial Development greater than 1 acre" means any commercial development that result in the disturbance of one acre or more of land.

"Detached Residential Development" means any development that provides 10 or more freestanding residential units. This category includes, but is not limited to: detached homes, such as single-family homes and detached condominiums.

"Directly Connected Impervious Area (DCIA)" means the area covered by a building, impermeable pavement, and/ or other impervious surfaces, which drains directly into the storm drain without first flowing across permeable vegetated land area (e.g., lawns).

"Environmentally Sensitive Areas" means areas that include, but are not limited to, all Clean Water Act 303(d) impaired water bodies ("303[d] water bodies"); areas designated as an "Area of Special Biological Significance" (ASBS) by the State Water Resources Control Board (*Water Quality Control Plan for the San Diego Basin* (1994) and amendments); water bodies designated as having a RARE beneficial use by the State Water Resources Control Board (*Water Quality Control Plan for the San Diego Basin* (1994) and amendments), or areas designated as preserves or their equivalent under the Multiple Species Conservation Program (MSCP) within the Cities and County of San Diego. The limits of Areas of Special Biological Significance are those defined in the *Water Quality Control Plan for the San Diego Basin* (1994 and amendments). Environmentally sensitive area is defined for the purposes of implementing SUSMP requirements, and does not replace or supplement other environmental resource-based terms, such as "Environmentally Sensitive Lands," employed by Copermittees in their land development review processes. As appropriate, Copermittees should distinguish between environmentally sensitive area and other similar terms in their Local SUSMPs.

"Hillside" means lands that have a natural gradient of 25 percent (4 feet of horizontal distance for every 1 foot of vertical distance) or greater and a minimum elevation differential of 50 feet, or a natural gradient of 200 percent (1 foot of horizontal distance for every 2 feet of vertical distance) or greater and a minimum elevation differential of 10 feet.

"Hillside development greater than 5,000 square feet" means any development that
would create more than 5,000 square feet of impervious surfaces in hillsides with known erosive soil conditions.

"Hydromodification" means the change in the natural hydrologic processes and runoff characteristics (i.e. interception, infiltration, overland flow, interflow and groundwater flow) caused by urbanization or other land use changes that result in increased stream flows and changes in sediment transport. In addition, alternation of stream and river channels, installation of dams and water impoundments, and excessive streambank and shoreline erosion are also considered hydromodification, due to their disruption of natural watershed hydrologic processes….

"Infiltration" means the downward entry of water into the surface of the soil.

"Low Impact Development (LID)" means a stormwater management and land development strategy that emphasizes conservation and the use of on-site natural features integrated with engineered, small-scale hydrologic controls to more closely reflect pre-development hydrologic functions.

"Maximum Extent Practicable (MEP)" means the technology-based standard established by Congress in the Clean Water Act 402(p)(3)(B)(iii) that municipal dischargers of urban runoff must meet. MEP generally emphasizes pollution prevention and source control BMPs primarily (as the first line of defense) in combination with treatment

methods serving as a backup (additional lines of defense).

“Natural Drainage” means a natural swale or topographic depression which gathers and/or conveys runoff to a permanent or intermittent watercourse or waterbody.

“New Development” means land disturbing activities; surface grading for structural development, including construction or installation of a building or structure, the creation of impervious surfaces; and land subdivision.

“Parking Lot” means land area or facility for the temporary parking or storage of motor vehicles used personally, or for business or commerce.

“Projects Discharging to Receiving Waters within Environmentally Sensitive Areas” means all development and significant redevelopment that would create 2,500 square feet of impervious surfaces or increase the area of imperviousness of a project site to 10% or more of its naturally occurring condition, and either discharge urban runoff to a receiving water within or directly adjacent (where any portion of the project footprint is located within 200 feet of the environmentally sensitive area) to an environmentally sensitive area, or discharge to a receiving water within an environmentally sensitive area without mixing with flows from adjacent lands (where the project footprint is located more than 200 feet from the environmentally sensitive area).
“Project Footprint” means the limits of all grading and ground disturbance, including landscaping, associated with a project.

"Receiving Waters" means surface bodies of water, which directly or indirectly receive discharges from urban runoff conveyance systems, including naturally occurring wetlands, streams (perennial, intermittent, and ephemeral (exhibiting bed, bank, and ordinary high water mark)), creeks, rivers, reservoirs, lakes, lagoons, estuaries, harbors, bays and the Pacific Ocean. The Copermittee shall determine the definition for wetlands and the limits thereof for the purposes of this definition, provided the Copermittee definition is as protective as the Federal definition utilized by the United States Army Corps of Engineers and the United States Environmental Protection Agency. Constructed wetlands are not considered wetlands under this definition, unless the wetlands were constructed as mitigation for habitat loss. Other constructed BMPs are not considered receiving waters under this definition, unless the BMP was originally constructed in receiving waters.

Construction of treatment control BMPs is prohibited in “Receiving Waters” may not be used to satisfy SUSMP requirements
“Residential Development” means any development on private land that provides living accommodations for one or more persons. This category includes, but is not limited to: single-family homes, multi-family homes, condominiums, and apartments.

“Restaurant” means a facility that sells prepared foods and drinks for consumption, including stationary lunch counters and refreshment stands selling prepared foods and drinks for immediate consumption (SIC code 5812), where the land area for development is greater than 5,000 square feet. Restaurants where land development is less than 5,000 square feet shall meet all SUSMP requirements except for structural treatment BMP and numeric sizing criteria requirement and hydromodification requirement.

“Sediment” means soils or other surficial materials eroded and then transported or deposited by the action of wind, water, ice, or gravity. Sediments can increase turbidity, clog fish gills, reduce spawning habitat, lower young aquatic organisms survival rates, smother bottom dwelling organisms, and suppress aquatic vegetation growth.

“Significant Redevelopment” means development that would create,add, or replace at least 5,000 square feet of impervious surfaces on an already developed site that falls under a priority development project categories. Where redevelopment results in an increase of less than 50% of the impervious surfaces of a previously existing development, and the existing development was not subject to SUSMP requirements, the numeric sizing criteria discussed in (***) applies only to the addition, and not to the entire development. When redevelopment results in an increase of more than 50% of the impervious surfaces of a previously existing development, the numeric sizing criteria applies to the entire development. Significant redevelopment includes, but is not limited to: the expansion of a building footprint; addition to or replacement of a structure; replacement of an impervious surface that is not part of a routine maintenance activity; and land disturbing activities related with structural or impervious surfaces. Replacement of impervious surfaces includes any activity that is not part of a routine maintenance activity where impervious material(s) are removed, exposing underlying soil during construction. Significant redevelopment does not include trenching and resurfacing associated with utility work; resurfacing and reconfiguring surface parking lots; new sidewalk construction, pedestrian ramps, or bikelane on existing roads; and replacement of damaged pavement.

“LID site design BMP” also known as a significant part of Low Impact Development (LID), means any project design feature that reduces the amount of impervious surfaces, disconnects impervious surfaces, reduces creation or severity of potential pollutant sources, and/or reduces the alteration of the project site’s natural flow regime.

Redevelopment projects that are undertaken to remove pollutant sources (such as existing surface parking lots and other impervious surfaces) or to reduce the need for new roads and other impervious surfaces (as compared to conventional or low-density new development) by incorporating higher densities and/or mixed land uses into the project design, are also considered LID site design BMPs.

“Source Control BMP (both structural and non-structural)” means land use or site planning practices, or structures that aim to prevent urban runoff pollution by reducing the potential for contamination at the source of pollution. Source control BMPs minimize the contact between pollutants and urban runoff. Examples include roof structures over trash or material storage areas, and berms around fuel dispensing areas.

“Storm Water Best Management Practice (BMP)” means any schedules of activities, prohibitions of practices, general good house keeping practices, pollution prevention and educational practices, maintenance procedures, structural treatment BMPs, and other management practices to prevent or reduce to the maximum extent practicable the discharge of pollutants directly or indirectly to receiving waters. Storm Water BMPs also include treatment requirements, operating procedures and practices to control site runoff, spillage or leaks, sludge or waste disposal, or drainage from raw material storage. This SUSMP groups storm water BMPs into the following categories: LID site design, source control, and treatment control (pollutant removal) BMPs.

“Storm Water Conveyance System” means private and public drainage facilities by which storm water may be conveyed to Receiving Waters, such as: natural drainages, ditches, roads, streets, constructed channels, aqueducts, storm drains, pipes, street gutters, or catch basins.

“Streets, Roads, Highways, and Freeways” means any project that is not part of a routine maintenance activity, and would create a new paved surface that is 5,000 square feet or greater used for the transportation of automobiles, trucks, motorcycles and other vehicles. For the purposes of SUSMP requirements, Streets, Roads, Highways and Freeways do not include trenching and resurfacing associated with utility work; applying asphalt overlay to existing pavement; new sidewalk, pedestrian ramps, or bikelane construction on existing roads; and replacement of damaged pavement.

“Treatment Control (Structural) BMP” means any engineered system designed and constructed to remove pollutants from urban runoff. Pollutant removal is achieved by simple gravity settling of particulate pollutants, filtration, biological uptake, media adsorption or any other physical, biological, or chemical process.

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APPENDIX G

Interim Hydromodification Criteria

BROWN AND CALDWELL

9665 Chesapeake Drive, Suite 201
San Diego, CA 92123
Tel: 858-514-8822
Fax: 858-514-8833

Memorandum

Project Title: San Diego County Hydrograph Modification Plan

Project No: 133904

San Diego County Hydrograph Modification Plan

Subject: Using Continuous Simulation to Size Storm water Control Facilities

Date: May 9, 2008

To: Sara Agahi, San Diego County

From: Tony Dubin, Brown and Caldwell
Nancy Gardner, Brown and Caldwell

Brown and Caldwell prepared this memo to help civil engineers through the process of sizing storm water control facilities to meet San Diego County's Interim Hydromodification Criteria (IHC). Since the publication of the IHC this past January, the County has been engaged in outreach activities to explain the new storm water modeling methods required by the IHC and storm water facilities that could meet the IHC performance standard. In response to the outreach efforts, the County has received several questions and comments along a common theme:

1. How do we perform continuous hydrologic modeling analyses to size storm water control facilities?
2. What is the precise meaning of the peak flow and flow duration curve matching standard described in the IHC memo?

This document is not a complete "how-to manual" for conducting continuous hydrologic modeling to meet the County's IHC, but we hope it addresses the major technical concerns of the local engineering community.

Using Continuous Simulation Models to Size Storm Water Facilities

The IHC requires continuous simulation hydrologic modeling to adequately size storm water control facilities. This is a significant break with the practice described in the County of San Diego's Hydrology Manual of using event-based modeling to determine whether a storm water pond, swale or other device was properly sized. Event-based modeling computes storm water runoff rates and volumes generated by a synthetic rainfall event with a total depth that matches local records (e.g., rainfall depths shown in County isopluvial maps). By contrast, continuous modeling uses a long time series of actual recorded precipitation data as input a hydrologic model. The model in turn simulates hydrologic fluxes (e.g., surface runoff, groundwater recharge, evapotranspiration) for each model time step.

Continuous hydrologic models are usually run using one-hour or 15-minute time steps, depending on the type of precipitation data available and computational complexity of the model. Continuous models generate outputs for each model time step and most software packages allow the user to output a variety of different hydrologic flux terms. For example, a continuous simulation model setup with 25 years of hourly precipitation data will generate 25 years of hourly runoff estimates, which corresponds to runoff estimates for each of the 219,000 time steps (each date and hour) of the 25 year simulation period. While creating and

running continuous simulation models involves more effort than running event-based models, the clear benefit of the continuous approach is that these models allow an engineer to estimate how often and for how long flows will exceed a particular threshold. Limiting how often and for how long geomorphically significant flows occur is at the heart of San Diego County's approach to hydrograph modification management.

Two common models were presented at a recent APWA workshop on HMP issues: HSPF and HEC-HMS. HSPF refers to the Hydrologic Simulation Program-FORTRAN and is distributed by the USEPA. HEC-HMS refers to the Hydrologic Modeling System (HMS) produced by the US Army Corps of Engineers Hydraulic Engineering Center (HEC). Engineers unfamiliar with these software packages should seek out training opportunities and online guidance. The USEPA conducts training workshops around the US to help teach engineers how to use HSPF. HEC-HMS training is provided through ASCE and third-party vendors.

The following list describes the major elements of developing a hydrologic model and using that model to size storm water facilities that meet the IHC.

1. Select an appropriate historical precipitation dataset for the analysis.
    a. The precipitation station should be located near the project site or at least receive similar rainfall intensities and volumes as the project site.
    b. The station should also have a minimum of 25-years of data recorded at hourly intervals or more frequently.
2. Develop a model to represent the pre-project conditions, including
    a. Land cover types
    b. Soil characteristics
    c. General drainage direction and slope
3. Develop a model to represent the post-project conditions, including
    a. New land cover types – more impervious surfaces
    b. Soil characteristics
    c. Any modifications to the drainage layout
4. Examine the model results to determine how the proposed development affects storm water flows
    a. Compute peak flow recurrence statistics (described below)
    b. Compute flow duration series statistics (described below)
5. Iteratively size storm water control facilities until the post-project peak flows and durations meet the performance standard described below.

Understanding the Peak Flow and Flow Duration Performance Criteria

The IHC is based on a peak flow and flow duration performance standard. To compute the peak flow and flow duration statistics described in the standard, model users must have a method for evaluating long time series outputs (usually longer than the 65,000 rows available in MS Excel 2003 and earlier versions) and computing both peak flow frequency statistics and flow duration statistics.

We recommend computing **peak flow frequency statistics** by constructing a partial-duration series rather than an "annual maximum" series, because the partial-duration series provides better resolution for assigning recurrence intervals to events that occur more frequently than once per 10 years, which are the events that are most important for the HMP This involves examining the entire runoff time series generated by the model, dividing the runoff time series into a set of discrete unrelated events, determining the peak flow for each

event, ranking the peak flows for all events and then computing the recurrence interval or plotting position for each storm event. To limit the number of discrete events to a manageable number, we usually only select events that are larger than a 3-month recurrence when generating the partial duration series. We consider flow events to be "separate" when flow rates drop below a threshold value for a period of at least 24 hours. The threshold should be less than the two-tenths of the 5-year flow rate that forms the lower limit to the IHC control range, but high enough to create a manageable number of events in the partial-duration series – less than 200 events.

The exercise described above will generate a table of peak flows and corresponding recurrence intervals (i.e., frequency of occurrence for a particular flow). For continuous modeling and peak flow frequency statistics, it is important to remember that events refer to *flow events* and not precipitation events. Peak flow frequency statistics estimate how often flow rates will exceed a given threshold. For example, the 5-year flow event represents the flow rate that is equaled or exceeded an average of once per 5 years (and the storm generating this flow does not necessarily correspond to the 5-year precipitation event). Ranking the storm events generated by a continuous simulation and computing the recurrence interval of each storm will generate a table similar to Table 1 below.

Readers who are unfamiliar with how to compute the partial-duration series should consult reference books or online resources for additional information. For example, *Hydrology for Engineers*, by Linsley et all, 1982, discusses partial-duration series on pages 373-374 and computing recurrence intervals or plotting positions on page 359. *Handbook of Applied Hydrology*, by Chow, 1964, contains a detailed discussion of flow frequency analysis, including Annual Exceedance, Partial-Duration and Extreme Value series methods, in Chapter 8. The US Geological Survey (USGS) has several hydrologic study reports available online that use partial-duration series statistics (see http://water.usgs.gov/ and http://water.usgs.gov/osw/bulletin17b/AGU_Langbein_1949.pdf).

Table 1. Example Peak Flow Frequency Statistics

Recurrence Interval (years)	Peak Flow (cfs per acre)
58.5	0.73
21.9	0.69
13.5	0.53
9.8	0.53
7.6	0.51
6.3	0.51
5.3	0.50
4.6	0.50
4.1	0.49
3.7	0.48
3.3	0.48
3.0	0.46
2.8	0.45
2.6	0.45
2.4	0.45
2.3	0.45
2.1	0.44
2.0	0.42

Flow duration statistics are more straightforward to compute than peak flow frequency statistics. Flow duration statistics provide a simple summary of how often a particular flow rate is exceeded. To compute the flow duration series, rank the entire runoff time series output and divide the results into discrete bins. Then, compute how often the flow threshold dividing each bin is exceeded. For example, let's assume the results of a 35-year continuous simulation hydrologic model with hourly time steps show that flows leaving a project site exceeded 5 cfs an average of about once per year for 30 hours at a time. This corresponds to a total of 1050 hours of flows exceeding 5 cfs over 35 years. Another way to express this information is to say a flow rate of 5 cfs is exceeded 0.34 percent of the time. Computing the "exceedance percentage" for other flow rates will fill out the flow duration series. Table 2 lists an example flow duration series.

Table 2. Example Flow Duration Statistics

Flow (cfs per acre)	Percent of Time Flow Rate is Exceeded
0.02	0.67%
0.03	0.43%
0.04	0.34%
0.06	0.27%
0.07	0.21%
0.09	0.17%
0.10	0.15%
0.12	0.12%
0.13	0.11%
0.15	0.09%
0.16	0.08%
0.17	0.07%
0.19	0.06%
0.20	0.05%
0.22	0.05%
0.23	0.04%
0.25	0.04%
0.26	0.03%

The intention of the IHC performance standard is to limit the potential for new development to generate accelerated erosion of stream banks and stream bed material in the local watershed by matching the post-project hydrograph to the pre-project hydrograph for the range of flows that are likely to generate significant amounts of erosion within the creek. The IHC memo identified the geomorphically significant flow range as extending from two-tenths of the 5-year flow to the 10-year flow (0.2Q5 to Q10). The performance standard requires the following:

A. For flow rates from 20% of the pre-project 5-year runoff event (0.2Q5) to the pre-project 10-year runoff event (Q10), the post-project discharge rates and durations shall not deviate above the pre-project rates and durations by more than 10% over more than 10% of the length of the flow duration curve.

B. For flow rates from 0.2Q5 to Q5, the post-project peak flows shall not exceed pre-project peak flows. For flow rates from Q5 to Q10, post-project peak flows may exceed pre-project flows by up to 10% for a 1-year frequency interval. For example, post-project flows could exceed pre-project flows by up to 10% for the interval from Q9 to Q10 or from Q5.5 to Q6.5, but not from Q8 to Q10.

Determining When a Storm Water Control Facility Meets the IHC Performance Standard

The previous section discussed how to calculate peak flow frequency and flow duration statistics. By comparing the peak flow frequency and flow duration series for pre-project and post-project conditions, an engineer can determine whether a stormwater control facility would perform adequately or if its size should be increased or decreased. The easiest way to determine if a particular storm water facility meets the IHC performance standard is to plot peak flow frequency curves and flow duration curves for the pre-project and post-project conditions.

Figure 1 shows a **flow duration curve** for a hypothetical development. The three curves show what percentage of the time a range of flow rates are exceeded for three different conditions: pre-project, post-project and post-project with storm water mitigation. For this hypothetical example, the computed minimum geomorphically significant flow rate is 0.10 cfs, which equals the pre-project 0.2Q5 flow. (The 0.2Q5 flow rate should be calculated using the partial-duration series method described above; values of 0.2Q5 will be site specific.) According to Figure 1, flows leaving the project site would equal or exceed this value about 0.14% of the time (about 12 hours per year). For post-project conditions, this flow rate would occur more often – about 0.38% of the time (about 33 hours per year). This increase in the duration of the geomorphically significant flow after development illustrates why duration control is closely linked to protecting creeks from accelerated erosion. Higher flows that last for longer durations provide the energy necessary to increase the amount of erosion in local creeks. The post-project mitigated condition would include stormwater controls designed to limit the duration of geomorphically significant flows. Figure 1 shows that flows exceed 0.10 cfs only 0.08% of the time, which is less than pre-project conditions. This means the stormwater control mitigations would counteract the effects of the increased pavement associated with development projects.

The flow duration plots should be examined to determine whether a stormwater control facility would meet the IHC. Looking at the flow range between 0.2Q5 and Q10, the post-project mitigated curve should plot on or to the left of the pre-project curve. If the post-project curve plots to the left of the pre-project curve, this means a particular flow would occur for shorter durations due to storm water controls. Minor deviations where the post-project durations exceed the pre-project durations are allowed over a short portion of the flow range as described in IHC item A above.

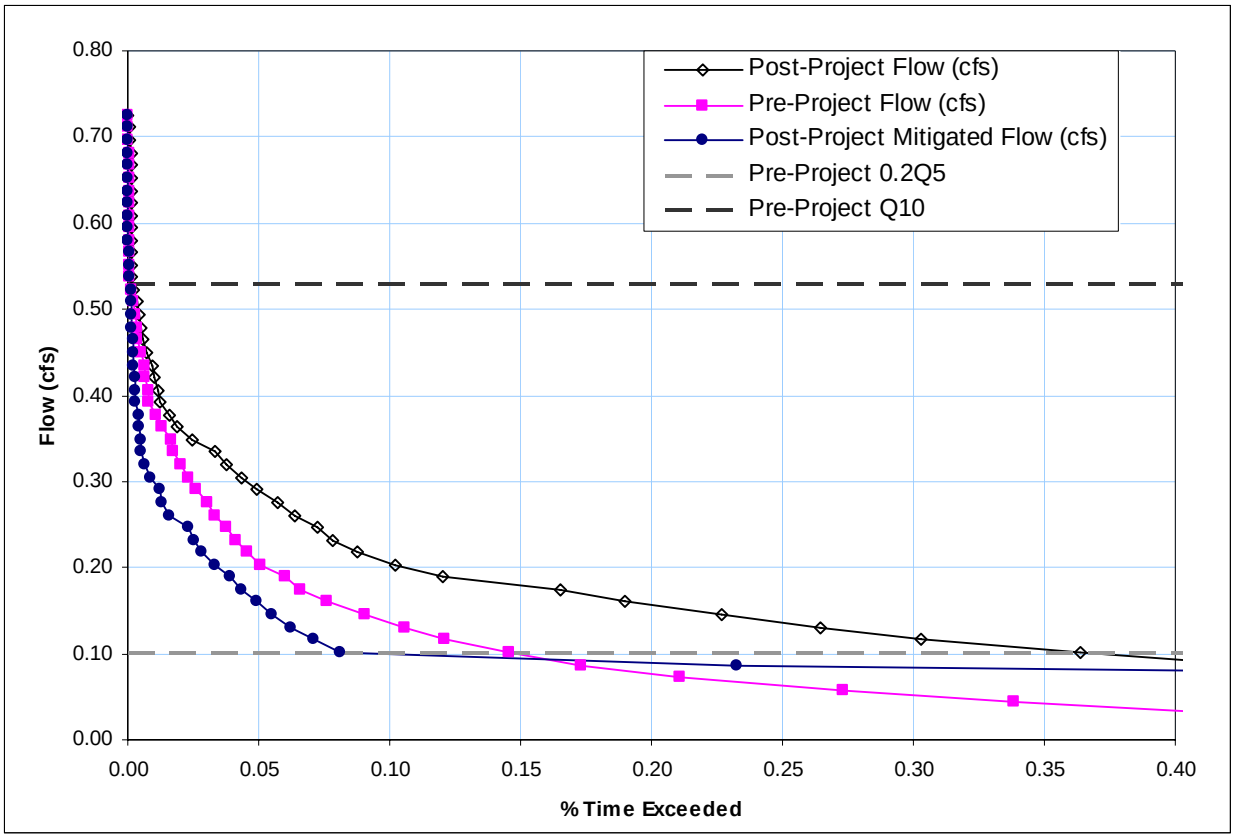

Figure 1. Flow Duration Series Statistics for a Hypothetical Development Scenario

Figure 2 shows a **peak flow frequency curve** for pre-project, post-project and post-project with storm water mitigation scenarios. The curves indicate how often a particular flow rate would be equaled or exceeded. For example, the pre-project 5 year flow rate would be 0.5 cfs per acre. This means under pre-project conditions, a flow rate of 0.5 cfs per acre would be equaled or exceeded an average of once per 5 years. For developed conditions, this 0.5 cfs per acre peak flow rate occur more often – about once per 1.5 years or, expressed another way, more than 3 times as often. The developed 5 year flow rate would increase by 30 percent over the pre-project condition, from 0.5 cfs per acre to about 0.65 cfs per acre.

Storm water control facilities should reduce peak flows from the site to levels less than or equivalent to the pre-project conditions. To determine whether a storm water facility provides sufficient protection, examine the peak flow frequency curves to see if the post-project mitigated peak flows are lower than pre-project peak flows of the same recurrence interval. The post-project mitigated scenario curve should plot below the pre-project curve for recurrence intervals between 0.2Q5 and Q10 to meet the IHC performance standard, with the possible exception of the small, allowable deviations described above in IHC item B.

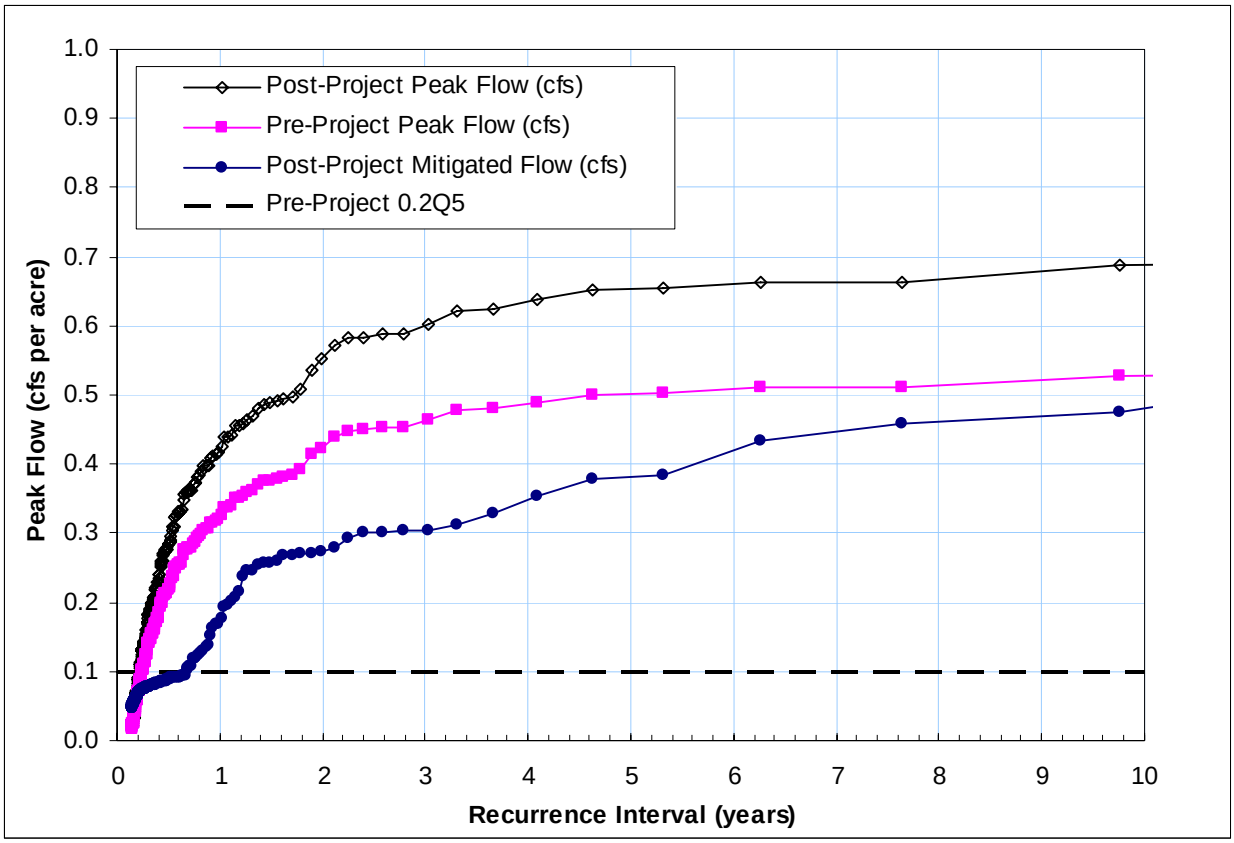

Figure 2. Peak Flow Frequency Statistics for a Hypothetical Development Scenario

In summary, this memorandum outlines the general methodology for using continuous simulation modeling and statistical analysis to size stormwater facilities to meet the IHC. The key steps involve developing a model to evaluate pre-project and post-project stormwater runoff, computing peak flow frequency and flow duration statistics and using these statistical results, via the graphical method shown in Figure 1 and Figure 2, to determine if a stormwater facility is adequately sized to meet the IHC performance requirements.

References

1) Linsley, RK Jr.; Koher, MA; Paulhas, JLH; Hydrology for Engineers, 1982; McGraw-Hill Inc.

2) Chow, VT; Handbook of Applied Hydrology, 1964; McGraw-Hill Inc.